FINAL
FOURTH YEAR LONG TERM MONITORING ANNUAL REPORT
LONG-TERM MONITORING OF SOLDIER CREEK

TINKER AIR FORCE BASE, OKLAHOMA

CONTRACT NO.: F34650-98-D-0032
DELIVERY ORDER 5003

JANUARY 2000

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Oklahoma City, Oklahoma
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FINAL

FOURTH YEAR LONG-TERM MONITORING ANNUAL REPORT FOR LONG-TERM MONITORING OF SOLDIER CREEK SEDIMENT AND SURFACE WATER OPERABLE UNIT

Document Prepared for:

Tinker Air Force Base
Environmental Directorate
OC-ALC/EM
Tinker AFB, Oklahoma

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This Internal Draft Fourth Year Long-Term [Monitoring Annual Report is intended for review by Tinker. The document incorporates sediment and surface water data collected during the fourth year of long-term monitoring, and the human health risk assessment IV (HHRA IV).

<u>Outline of Document</u>

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- Background
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- Human Health Risk Assessment IV
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LIST OF ACRONYMS

1Qtr1Yr	First Quarter First Year
2Qtr1Yr	Second Quarter First Year
3Qtr1Yr	Third Quarter First Year
4Qtr1Yr	Fourth Quarter First Year
1Qtr2Yr	First Quarter Second Year
2Qtr2Yr	Second Quarter Second Year
3Qtr2Yr	Third Quarter Second Year
4Qtr2Yr	Fourth Quarter Second Year
1Evnt3Yr	First Event Third Year
2Evnt3Yr	Second Event Third Year
1Evnt4Yr	First Event Fourth Year
2Evnt4Yr	Second Event Fourth Year
AOC	Area of Concern
ACC	Air Combat Command
AFB	Air Force Base
AFMC	Air Force Materiel Command
bgs	Below Ground Surface
BHRA	Baseline Health Risk Assessment
CAA	Clean Air Act
CERCLA	Comprehensive Emergency Response and Compensation Liability Act
COC	Contaminant of Concern
CWA	Clean Water Act
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DRMO	Defense Reutilization and Marketing Office
EM	Environmental Management
EPA	Environmental Protection Agency
FFA	Federal Facilities Agreement
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Indices
HPLC	High Performance Liquid Chromatography
IRP	Installation Restoration Program
IRIS	Integrated Risk Information System
I-40	Interstate Highway 40
IWTP	Industrial Wastewater Treatment Plant
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NPDES	National Pollution Discharge Elimination System
NPL	National Priority List
OSDH	Oklahoma State Department of Health
OU	Operable Unit

LIST OF ACRONYMS (continued)

PAH	Polyaromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendment and Reauthorization Act
STP	Sanitary Treatment Plant
SVOC	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TCE	Trichloroethene
TIC	Tentatively Identified Compound
TSCA	Toxic Substance Control Act
VOC	Volatile Organic Compound
USAF	United States Air Force
WCFS	Woodward-Clyde Federal Services

EXECUTIVE SUMMARY

Long-term monitoring of the Sediment and Surface Water Operable Unit of Soldier Creek at Tinker Air Force Base is conducted in response to the signed Record of Decision (ROD), dated September, 1993. The focus of the monitoring program is to evaluate sediment and surface water contamination at the Soldier Creek Sediment and Surface Water Operable Unit from the headwaters of East and West Soldier Creeks to Interstate Highway 40.

This report summarizes findings from the fourth year of long-term monitoring. The first year of monitoring is presented in the Final Quarterly Monitoring Annual Report (WCFS, 1997a). The second year of monitoring is presented in the Draft Second Year Quarterly Monitoring Report (WCFS, 1997b). The third year of monitoring is presented in the Draft Third Year Long-Term Monitoring Report (WCFS, 1998a). The fourth year of long-term monitoring occurred in January and July 1998. During the fourth year of monitoring, a total of 63 sediment and 30 surface water samples were collected from East and West Soldier Creeks and a sample location on Tributary B. Surface water samples were collected prior to sediment sampling. Sediment samples were collected at three intervals, from 0-6 inches, 6-12 inches and 3-5 feet below ground surface (bgs). When refusal of the sampling device occurred prior to 5 feet bgs, a sediment sample was typically collected from the bottom one foot interval of the boring.

Samples were analyzed for volatile organics, semi-volatile organics, metals, polychlorinated biphenyl's (PCBs), and pesticides. Surface water samples were also analyzed for the following wet chemistry parameters: alkalinity, chemical oxygen demand, hardness, total dissolved solids, total organic carbon, total suspended solids, chloride, and sulfate. Dissolved metals analysis was performed on surface water samples during the first event fourth year (1Evnt4Yr) monitoring event. Hexavalent chromium analysis was performed on sediment (0-6 inch bgs) and surface water samples during the 1Evnt4Yr monitoring event. Surface water measurements performed in the field included temperature, pH, conductivity, dissolved oxygen, and flow.

An evaluation of risks associated with Soldier Creek surface water and sediments was previously performed by Black and Veatch (B&V) in the Baseline Health Risk Assessment (BHRA) (B&V, 1993a). Human Health Risk Assessments I, II, & III (HHRA I, II, & III) (WCFS, 1997a and b, WCFS 1998a) were performed for the first, second, and third years of long-term monitoring, respectively. As part of this project, the Human Health Risk Assessment IV (HHRA IV) was performed to provide updated information on potential current and future risks based on current surface water and sediment contaminant levels, compare the results with those of the previous HHRAs to see if the previous conclusions are still valid, and develop updated cleanup goals that are protective of the human populations.

Screening criteria were based on exposure factors developed by the BHRA for human health under the RI/FS, and the HHRA I. Analyte concentrations detected in sediment and surface water were screened against these screening criteria. Unacceptable exposures were determined based on the following criteria:

- Contaminant concentrations in sediment or surface water exceeding health levels based on an excess lifetime cancer risk of 10^{-4}
- Contaminant concentrations in sediment or surface water with non-carcinogenic hazard indices (HIs) greater than 1.0

Contaminant concentrations detected in the 10^{-4} to 10^{-6} range may potentially indicate an unacceptable exposure level and were also evaluated.

Surface water analyte concentrations from the fourth year of monitoring did not exceed any of the screening criteria set forth in the BHRA or HHRA I noncarcinogenic, 10^{-4} or 10^{-5} screening criteria. During the 1E4Y event the HHRA 10^{-6} screening criteria for bis(2-Ethylhexyl)phthalate) was exceeded in one segment (QE02) on East Soldier Creek during 1Evnt4Yr monitoring.

Sediment analyte concentrations from the fourth year of monitoring did not exceed the 10^{-4} screening criteria set forth in the BHRA and the HHRA I. However, the HHRA I noncarcinogenic hazard screening criteria for aroclor 1254 was exceeded at one location in segment QW03 on West Soldier Creek.

BHRA 10^{-6} screening criteria were exceeded by five semivolatile (SVOCs) classified as polyaromatic hydrocarbons (PAHs). These include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and chrysene. HHRA I 10^{-6} screening criteria were exceeded by five PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. HHRA I 10^{-5} screening criteria were exceeded by benzo(a)pyrene and dibenz(a,h)anthracene in sediment samples. Based on the ROD, exceedance of these 10^{-5} and 10^{-6} screening criteria may potentially indicate a need to evaluate if the exposure is unacceptable.

The results of the risk characterization indicate that for all scenarios, potential cancer risks are below or within the USEPA advisory range of 10^{-6} to 10^{-4} and the USEPA noncarcinogenic health hazard of 1.0. These results indicate that exposure to surface water and sediments in West and East Soldier Creeks is not likely to result in an unacceptable cancer risk or noncarcinogenic hazard for any on-base or off-base populations under current or future stream use conditions.

The results of the current risk analysis were compared to the results from the three previous HHRAs. It should be noted that the methodology used in the current risk analysis was slightly different than the methodology used in the three previous HHRAs. The 1996 USEPA Region IV Supplemental Risk Guidance (USEPA 1996) was followed for this assessment and the 1991 USEPA Region IV Guidance (USEPA 1991d) was followed for the previous assessments. The largest difference between the current and the previous HHRAs was the methodology used to select the COPCs, which resulted in different COPCs being selected. Therefore, the risk assessments are not completely comparable. In general, no dramatic changes between the first three WCFS HHRAs and the current (fourth year) HHRA IV were identified. The differences in estimated noncarcinogenic hazards and carcinogenic risks are due to changes in contaminant concentrations and the chemicals that were detected in the sediment and surface water. These differences are expected because the stream is a dynamic system affected by factors such as precipitation levels. Effluent outfall flow and concentrations also impact the dynamics of the stream system. Like heavy precipitation, large volumes of effluent outfall may dilute concentrations in the stream system. Therefore, it is possible for concentrations in the stream to rise despite the closure of outfalls. The differences between the HHRA IV and the three previous HHRAs may also be attributed to the use of a different method to select the COPCs for quantitative evaluation in the HHRA. Despite slightly different methodologies, the calaculated risks still do not pose an unacceptable threat to human health.

To date, none of the HHRAs indicated any unacceptable adverse noncarcinogenic health effects or cancer risks associated with exposure to West or East Soldier Creeks for any on-base or off-Base population under current or future stream use conditions. Consequently, no remedial action is necessary based on risks to human health. As part of the HHRA, health-protective cleanup goals were developed for each COPC. Although remediation is not currently warranted based on risk to human health, the cleanup goals provide a set of "action criteria" should remediation be required in the future.

1. INTRODUCTION

1.1 Regulatory Basis

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986 established the Defense Environmental Restoration Program (DERP) for the U.S. Department of Defense (DoD) to clean up past hazardous waste disposal and spill sites nationwide. In 1980, the United States Air Force (USAF) began implementing the DoD Installation Restoration Program (IRP). The IRP is designed to identify and evaluate suspected problems associated with past hazardous waste management practices, including impacts on human health and the environment.

Two sites located within Tinker AFB, Building 3001 and Soldier Creek, were listed on the CERCLA National Priority List (NPL) in 1987. Tinker AFB, EPA Region VI, and the Oklahoma State Department of Health (OSDH) signed a Federal Facilities Agreement (FFA) (Administrative Docket Number NPL-U3-2-27) under Section 120 CERCLA in December 1988. The intent of this agreement is to ensure that past and present activities of Tinker AFBs NPL sites are thoroughly investigated and appropriately remediated to protect the public health, welfare, and the environment.

Long-term Monitoring of the Sediment and Surface Water Operable Unit of Soldier Creek at Tinker Air Force Base (Tinker AFB) was conducted in response to the signed Record of Decision (ROD), dated September, 1993.

1.2 Investigation Scope and Objectives

The focus of this monitoring program is sediment and surface water contamination from the Soldier Creek Sediment and Surface Water Operable Unit (OU) from the headwaters of East and West Soldier Creeks to Interstate Highway 40 (I-40). The site description is discussed further in Section 2.2. The Soldier Creek OU is located in the northeast portion of Tinker AFB and was identified in the ROD as a potential threat to human health and the environment. The objective of long-term monitoring is to evaluate analytical results of sediment and surface water samples for exceedance of health based cleanup goals developed during the Baseline Health Risk Assessment (BHRA) (B&V, 1993a), and reported in the ROD (B&V, 1993b).

1.3 Report Organization

This report describes the results of the fourth year of long-term monitoring of the Soldier Creek OU.

Section 1 is the introduction describing the regulatory basis of the study, and the objectives and scope of the monitoring program.

Section 2 describes Tinker AFB and the project site. This section also summarizes site history and previous investigations.

Section 3 describes sampling methods used during long-term monitoring of sediments and surface water .

Section 4 contains a brief summary of the Human Health Risk Assessment IV presented in Appendix A.

Section 5 contains a review and discussion of sampling results and analytical exceedances of screening criteria.

Section 6 presents conclusions from the fourth year of long-term monitoring.

Section 7 presents the list of references cited.

2. BACKGROUND

2.1 Installation Description and History

Tinker AFB is located in Oklahoma County in central Oklahoma approximately 8 miles southeast of downtown Oklahoma City. The base is bounded by Sooner Road to the west, Douglas Boulevard to the east, I-40 to the north, and Southeast 74th Street to the south. The base is comprised of approximately 5,277 acres. Municipalities of the metro area which adjoin Tinker AFB are Midwest City to the north, Del City to the northwest, and Oklahoma City to the east, south, and southwest (Figure 2-1). Midwest City and Del City are heavily populated with mixed residential and commercial areas. The area under Oklahoma City jurisdiction is lightly developed residential.

To attract the war industries in the early 1940's, Oklahoma City donated the land required for the facility and offered necessary improvements at no cost to the War Department. The Oklahoma Industries Foundation was established to bid for a military maintenance and supply depot and to acquire the land for the site. Oklahoma City was considered a favorable location for the depot for several reasons, including mild winters, flat terrain, and strategic location near the geographic center of the United States. During this period, Midwest City was formed as a new town to provide housing and community facilities for the air depot. The original site, consisting of 960 acres, was selected by the Army on May 21, 1941, seven months before the United States officially entered World War II.

The name designations for the Oklahoma City Air Depot and Tinker Air Field have changed several times over the life of the base, as the depot and air base were redesignated and reorganized. Tinker AFB was officially known as Midwest Air Depot during its construction, and then as the Oklahoma City Air Depot after it was activated. In January 1943, the name of the depot was officially changed to Oklahoma City Air Depot Control Area Command. In May 1943, the name was changed to Oklahoma Air Technical Area Service Command to reflect new responsibilities at the depot. The name changed again in July 1946, to Oklahoma City Air Material Area. In 1974, the depot was redesignated Oklahoma City Air Logistic Center to reflect the last change in function at the depot.

Pressure from local citizens was instrumental in the decision to name the air field at the depot "Tinker Field", honoring General Clarence L. Tinker. Tinker was an Osage Indian who died in 1942 while leading a bomber strike against the Japanese at Wake Island. Following the creation of the DoD and the Air Force as a separate military establishment, Tinker Field became "Tinker Air Force Base" on January 13, 1948. Subsequently, the base became the worldwide repair depot for B-36 and B-45 aircraft, as well as a multitude of other weapons and engines.

The Oklahoma City Air Depot was partially operational in 1942. Tinker Air Field was built adjacent to and concurrently with the depot. The Douglas Cargo Airplane Plant was built in 1942-1943 to manufacture specially modified DC-3s. The depot and aircraft plant shared Tinker Air Field. After World War II, the Douglas Cargo Aircraft Plant was closed and the

Air Depot took over the buildings and expanded the Base operations, to include facilities for testing and overhauling jet engines. During this time, Tinker AFB became involved in jet engine overhaul and, later, modification of aircraft from storage as part of a massive program to rebuild the nation's air power.

The Korean and the Cold War occurred during 1950-1959. As the decade began, the Tinker work force was much smaller than in the World War II days. The base was still a major employer with 10,000 people and was the home of the largest Air Depot in the United States.

TAFB was involved in many events that took place as the decade of the sixties unfolded. Tinker was one of the most active bases in the Air Force during the Cuban missile crisis, as aircraft used the installation as a stepping stone to and from the southeastern part of the United States. Even before this, Tinker's central location helped rank it fifth in takeoff and landing activity among all non-training Air Force bases.

During the early 1970s, the F-4 phantom became an important specialized repair workload at TAFB. On February 28, 1977, OC-ALC was named provisional manager of the ground launched cruise missile.

An important development during the 1980s was the increased emphasis on environmental management. In 1985, a separate Directorate of Environmental Management (EM) was formed at Tinker. The new Directorate incorporated functions related to environmental laws such as the Clear Air Act (CAA), Clean Water Act (CWA), Resource Conservation and Recovery Act (RCRA), CERCLA as amended by SARA, and Toxic Substances Control Act (TSCA).

As early as 1983, measures to remediate sites at Tinker AFB contaminated by past activities were being undertaken under the Air Force IRP. As part of the overall IRP, Tinker AFB began a preliminary assessment of previous waste disposal sites in 1981. As a result of a basewide-sampling program in 1983, which detected trichloroethene (TCE) in the groundwater, extensive investigations were conducted in and around Building 3001. Two sites, Building 3001 and Soldier Creek were listed on the CERCLA NPL in 1987. In 1988, Tinker AFB signed the FFA with EPA and the State of Oklahoma to remediate these sites. A RCRA Facility Assessment (RFA) conducted in May 1989 identified 105 Solid Waste Management Units (SWMUs) and nineteen Areas of Concern (AOCs).

The base was issued a RCRA Part B permit on July 1, 1991. The permit specified that a RCRA Facility Investigation (RFI) be conducted for forty-three SWMUs and two AOCs. The Directorate of Environmental Management has now grown to approximately eighty personnel and works closely with the Bio-environmental Office and the Office of Safety.

In 1992, major organizational changes occurred in response to the end of the cold war and the down sizing of the entire military structure. Of most importance to the OC-ALC is the fact that on July 1, 1992, its parent command, Air Force Logistics Command (AFLC), was merged with the Air Force Systems Command to form the Air Force Materiel Command (AFMC). The new command comprises 52 percent of the Air Force budget. Eighteen percent of all Air Force personnel and 42 percent of the civilian workforce are assigned to the new command.

2.2 Site Description and History

The Soldier Creek Sediment and Surface Water OU is composed of the two unnamed tributaries to Soldier Creek that originate on Tinker AFB (Figure 2-2). The tributary east of Building 3001 is designated East Soldier Creek and the tributary west of Building 3001 is designated West Soldier Creek. The boundaries for the study were:

- All sediment and surface water of East Soldier Creek that originates on Tinker AFB to the intersection of East Soldier Creek and I-40 north of Tinker AFB
- All sediment and surface water of West Soldier Creek that originates on Tinker AFB to the intersection of West Soldier Creek and I-40 north of Tinker AFB

These initial boundaries included the ditches leading from the thirteen outfalls, eight of which are National Pollutant Discharge Elimination System (NPDES) outfalls, to East and West Soldier Creeks. The boundaries also included the lower portion of Tributary B, as defined in the Remedial Investigation/Feasibility Study (RI/FS) (B&V, 1993c), just upstream of its confluence with East Soldier Creek.

Data from the RI indicated that a contaminant concentration gradient exists to a point just south (upstream) of the study boundary. The study area boundary was established based on the following criteria:

- Limits of measurable levels of contaminants (as compared to background locations)
- Area of such size that a definitive assessment could be performed
- Allowance for source identification

The study area boundary was determined by comparing the Phase I and Phase II Remedial Investigation (RI) sampling results to one-tenth of the risk based clean-up levels established in the baseline health risk assessment. Sediment and surface water of Soldier Creek with greater than one-tenth the risk-based clean-up levels were included in the study boundary.

2.2.1 East Soldier Creek

East and West Soldier Creeks drain the northeastern portion of Tinker AFB. Both streams are first-order (headwater) tributaries that have been substantially modified over the years (Figure 2-2). East Soldier Creek now originates where several storm sewers, known as Outfalls H, I, and J, emerge from the north side of 44th Street (north of Building 3705). The emerged portion of East Soldier Creek flows northward about 500 feet and is joined by a tributary from the west which is fed by process effluent and cooling water blow-down (Outfall G). The combined flow continues about 630 feet northward along the east side of Building 3001 to a culvert at Bradley Drive, near which two storm water ditches (Outfalls M and L) enter from the west. This portion of the creek flows in a narrow channel through dense woods. The substrate is mainly bedrock (sandstone), with occasional areas of gravel and sand; virtually no fine-grained depositional sediment is present in this portion of East Soldier Creek.

After crossing under Bradley Drive, East Soldier Creek has a short stretch of flowing water and then becomes an elongated pond, about 600 feet long by 75 feet wide and terminating at a dam. Approximately midway along the pond a tributary fed from process effluent and storm water discharge (Outfall F) enters from the west. Except for the flowing stretch near Bradley Drive, the entire ponded portion of East Soldier Creek is depositional, with relatively thick organically rich silt and fine sand sediments.

Normal flows from the ponded portion of East Soldier Creek are diverted via underground piping through a concrete detention basin (former oil/water separator). Downstream from the dam the stream has a divided channel, the easternmost is fed by the culvert from the detention basin, and the westernmost of which during normal flow is backwater and during storm events is fed by the dam overflow. Between the dam and Douglas Boulevard, East Soldier Creek bends eastward. This stretch is about 400 feet long, varying from about 20 to 40 feet in width with sand, silt and gravel substrate and moderate flows. The Industrial Wastewater Treatment Plant (IWTP) and Sanitary Treatment Plant (STP) outfall to East Soldier Creek is located about a third of the way between the dam and Douglas Boulevard. The IWTP receives industrial process wastewater for treatment from the Building 3001, as well as process wastewater from other industrial sources throughout the base, via a network of underground piping. In April 1996, the IWTP/STP discharge was rerouted to the Oklahoma City Public Owned Treatment Works, and discharge to East Soldier Creek ceased. The IWTP is currently utilized for pretreatment of industrial waste. In case of emergency, discharges to East Soldier Creek from the IWTP/STP may occur under NPDES Permit OK1571724391.

Near where the stream exits Tinker under Douglas Boulevard, a large storm water conveyance enters from the north. Beyond Douglas Boulevard, East Soldier Creek flow east-northeastward about 800 feet and is joined by an intermittent tributary (Tributary B) from the south. The stream then flows north-northeast about 1,200 feet to I-40. This off-base stretch is in a deeply incised channel with steep clay banks, surrounded by commercial and residential property near Douglas Boulevard and riparian woodlands beyond Tributary B. Tributary B headwaters are located just upstream of S.E. 36th Street where it flows northward to its confluence with East Soldier Creek north of S.E. 36th Street and east of Douglas Boulevard. East Soldier Creek begins to assume a quasi-natural riffle-and-pool configuration in this stretch, with natural substrates predominated by gravel, sand, and silt. There are also substantial amounts of concrete rubble and other anthropogenic debris (e.g., discarded appliances, automobile parts, household trash) in this section of the stream. Beyond I-40, East Soldier Creek flows northward to its confluence with the mainstream of Soldier Creek, which originates off-base near Southeast 59th Street, about 1.5 miles south-southeast of the Building 3001 Complex.

Table 2-1 presents the buildings and associated outfalls which contribute discharge to East Soldier Creek.

2.2.2 West Soldier Creek

West Soldier Creek starts between the Tinker North/South runway and Building 3001 in a broad grassy swale (Figure 2-2). It flows northward about 3,500 feet and is fed by runoff from the runways and the area west of Building 3001 and from several outfalls (Outfalls A, B, C, D, and E), which normally discharge very little to no water. Table 2-1 presents the buildings and associated outfalls, which contribute discharge to West Soldier Creek.

The drainage continues to a point opposite the north end of Building 3001, enters a storm sewer, and emerges off-base from under Industrial Road to flow parallel to and then cross under I-40. A small tributary, which drains the north parking lot to Building 3001, and undeveloped Tinker property, joins West Soldier Creek off base, midway between Industrial Road and I-40. The off-base reach of West Soldier Creek is moderately incised, with substrates consisting of bedrock, gravel, sand, and substantial amounts of concrete rubble. Riparian habitat consists of a narrow band of trees along most of the highway side, and wooded slope on the base side. This reach is approximately 500 feet long and is divided by a spill containment structure midway from its emergence from on-base Tinker and the culverts at I-40. North of I-40, West Soldier Creek flows northeastward through a mixed residential/commercial area and joins the mainstream of Soldier Creek, just west of Douglas Boulevard. From this point, Soldier Creek flows north-northwest approximately 3 miles to join Crutcho Creek, which continues northward about 2 miles and enters the North Fork of the Canadian River.

In July 1998, the on-base channel of West Soldier Creek was excavated. A concrete lining was installed along the entire on-base, above-ground portion of West Soldier Creek.

2.2.3 Previous Investigations

Table 2-2 presents a brief summary of previous activities conducted on or near the Soldier Creek OU under the IRP. On July 22, 1987, the Building 3001 Site and Soldier Creek Site were added to the NPL. In 1990 and 1991, B&V conducted a Phase I and a Phase II RI/FS to determine the extent of sediment and surface water contamination along East, West and Main Soldier Creek. The baseline health risk assessment performed by B&V (1993a) determined that the sediment and surface water of the Soldier Creek OU do not pose a risk to human health in excess of acceptable risk-based exposure levels established by the EPA.

In accordance with the requirements of the ROD, the first year of Soldier Creek long-term monitoring occurred in November 1994, and January, April, and June 1995 and is presented in the Final Quarterly Monitoring Annual Report for Long-Term Monitoring of Soldier Creek Sediment and Surface Water Operable Unit (WCFS, 1997a). The second year of long-term monitoring occurred in October 1995, March, May, and August 1996 and is presented in the Draft Second Year Quarterly Monitoring Report for Long-Term Monitoring of Soldier Creek Sediment and Surface Water Operable Unit (WCFS, 1997b). The third year of long-term monitoring occurred in January and July 1997 and is presented in the Draft Third Year Long-Term Monitoring Annual Report for Long-Term Monitoring of Soldier Creek Sediment and Surface Water Operable Unit (WCFS, 1998a).

Initial results of the ecological assessment of Soldier Creek is presented in the Final Ecological Assessment (WCFS, 1997c). Results for the additional ecological assessment, which occurred in June 1997, are presented in the Draft Ecological Assessment II Report for the 1997 Ecological Assessment of Soldier Creek (WCFS, 1998b).

Sediment analyte concentrations from the first year of quarterly monitoring did not exceed the 10^{-4} screening criteria set forth in the BHRA and the HHRA. Therefore, according to the

ROD, because contaminants of concern did not exceed the 10^{-4} screening criteria another alternative for remediation does not need to be evaluated (B&V, 1993b).

During the first year of quarterly monitoring, BHRA 10^{-6} screening criteria were exceeded by six PAHs (benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene), HHRA I 10^{-5} screening criteria were exceeded by one pesticide (heptachlor), and one PAH (benzo(a)pyrene), and HHRA I 10^{-6} screening criteria were exceeded by two pesticides (aldrin and heptachlor) and six semivolatiles (benzidine, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene).

The results of the HHRA I were compared to those presented in the BHRA. Despite slight differences in approach, both risk assessments concluded that there are no unacceptable cancer risks or non-carcinogenic hazards associated with exposure to East or West Soldier Creeks for any on-base or off-base populations, under current of future stream use conditions.

During the second year of quarterly monitoring, BHRA 10^{-6} screening criteria were exceeded by six SVOCs classified as PAHs (benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene), HHRA I 10^{-6} screening criteria were exceeded by two pesticides (aldrin and heptachlor) and six SVOCs (benzidine, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene), and HHRA I 10^{-5} screening criteria were exceeded by one pesticide (heptachlor), and one SVOC (benzo(a)pyrene) in sediment samples.

Sediment analyte concentrations from the second year of quarterly monitoring did not exceed the 10^{-4} screening criteria set forth in the BHRA and the HHRA I. However, at location QW03 the non-carcinogenic screening criteria for aroclor 1254 was exceeded.

The results of the HHRA II were compared to those presented in the HHRA I. The results of the comparison between the HHRA I and HHRA II showed no dramatic changes. Although the non-carcinogenic screening criteria was exceeded by one sample on-base West Soldier Creek, under the worker scenario, the exceedance does not trigger an unacceptable non-carcinogenic hazard.

During the third year of monitoring, BHRA 10^{-6} screening criteria were exceeded by five semivolatile (SVOCs) classified as polyaromatic hydrocarbons (PAHs). These include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and chrysene. HHRA I 10^{-6} screening criteria were exceeded by three PAHs benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene. HHRA I 10^{-5} screening criteria were exceeded by benzo(a)pyrene and dibenz(a,h)anthracene in sediment samples. Based on the ROD, exceedance of these 10^{-5} and 10^{-6} screening criteria may potentially indicate a need to evaluate if the exposure is unacceptable.

Sediment analyte concentrations from the fourth year of monitoring did not exceed the 10^{-4} screening criteria set forth in the BHRA and the HHRA I. However, the HHRA I noncarcinogenic hazard screening criteria for aroclor 1254 was exceeded at one location in segment QW03 on West Soldier Creek.

Surface water analyte concentrations from the first three years of monitoring did not exceed any of the screening criteria set forth in the BHRA and the HHRA I.

Surface water analyte concentrations from the fourth year of monitoring did not exceed any of the screening criteria set forth in the BHRA or HHRA I noncarcinogenic, 10-4 or 10-5 screening criteria. During the 1E4Y event the HHRA 10-6 screening criteria for bis(2-Ethylhexyl)phthalate) was exceeded at one location is segment QE02 on East Soldier Creek.

Sediment analyte concentrations from the fourth year of monitoring did not exceed the 10^{-4} screening criteria set forth in the BHRA and the HHRA I. However, the HHRA I noncarcinogenic hazard screening criteria for aroclor 1254 was exceeded at one location in segment QW03 on West Soldier Creek.

BHRA 10^{-6} screening criteria were exceeded by five semivolatile (SVOCs) classified as polyaromatic hydrocarbons (PAHs). These include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and chrysene. HHRA I 10^{-6} screening criteria were exceeded by five PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. HHRA I 10^{-5} screening criteria were exceeded by benzo(a)pyrene and dibenz(a,h)anthracene in sediment samples. Based on the ROD, exceedance of these 10^{-5} and 10^{-6} screening criteria may potentially indicate a need to evaluate if the exposure is unacceptable.

TABLES

TABLE 2-1
SOLDIER CREEK
OUTFALLS AND ASSOCIATED BUILDINGS/STRUCTURES

Location	Outfall	Building	
West Soldier Creek	A	3001	Aircraft overhaul and modification facility
	B	--	Drains roadway
	C	3001	Aircraft overhaul and modification facility
	D	3001	Aircraft overhaul and modification facility
	E	3001	Aircraft overhaul and modification facility
		3108	Hydraulic test and calibration
	N	--	Drains Outfalls A, B, C, D, E
East Soldier Creek	F	3001	Aircraft overhaul and modification facility
	G	3001	Aircraft overhaul and modification facility
	H	2122	Airframe paint stripping
		2210	Accessories
		3001	Aircraft overhaul and modification facility
		3102	Hangar and Fire Station
		3105	Hangar and process vacuum heat treat area
		3220	Missles and Avionics
		3221	Blade repair
		3234	Jet engine test stands
		3703	Jet engine test stands
	I	2122	Airframe paint stripping
		2210	Accessories
		3001	Aircraft overhaul and modification facility
		3102	Hangar and Fire Station
		3105	Hangar and process vacuum heat treat area
		3220	Missles and Avionics
		3221	Blade repair
		3234	Jet engine test stands
		3703	Jet engine test stands
	J	--	Drains roadway and DRMO area
	L	3001	Aircraft overhaul and modification facility
	M	--	Drains roadway

Adapted from NUS (1989)

TABLE 2-2
SUMMARY OF PREVIOUS INVESTIGATIONS AND ACTIVITIES

INVESTIGATION/REPORT	ORGANIZATION	DATE
Quarterly Groundwater Sampling	Tulsa COE	December 1987 - March 1989, March and October 1988
Surface Water Sampling	Tinker AFB	March - September 1987
Sediment and Surface Water Sampling	Oklahoma State Department of Health	June 1987
NPDES Surface Water Sampling	Tinker AFB	September 1986 - July 1987
Sediment and Surface Water Sampling	EPA	October 1984, November 1984
Sediment Sampling and Dredging	Harry Keith & Sons, Inc.	October 1985, April and May 1986
Final Storm Sewer Investigation for Soldier Creek	NUS Corporation	October 1989
Industrial Wastewater Treatment Plant Remedial Investigation	Tulsa COE	March 1988 - September 1990
Soldier Creek Remedial Investigation, Phase I and II	B&V Waste Science and Technology Corporation	July 1990, June 1991
Soldier Creek Baseline Risk Assessment	B&V Waste Science and Technology Corporation	February 1993
Soldier Creek Record of Decision	B&V Waste Science and Technology Corporation	August 1993
Workplans for Long-Term Monitoring and Ecological Assessment of Soldier Creek	Woodward-Clyde Federal Services	June 1994
Draft Ecological Assessment	Woodward-Clyde Federal Services	January 1996
Long-Term Monitoring of Sediment and Surface Water	Woodward-Clyde Federal Services and CH2M HILL	November 1994, January, April, July, and October 1995, March, May, and August 1996, January and July 1997, January and July 1998
Soldier Creek/Off-Base Groundwater Operable Unit, Remedial Investigation	Parsons Engineering Science	July 1995

source: B&V 1993, and PES 1995

FIGURES

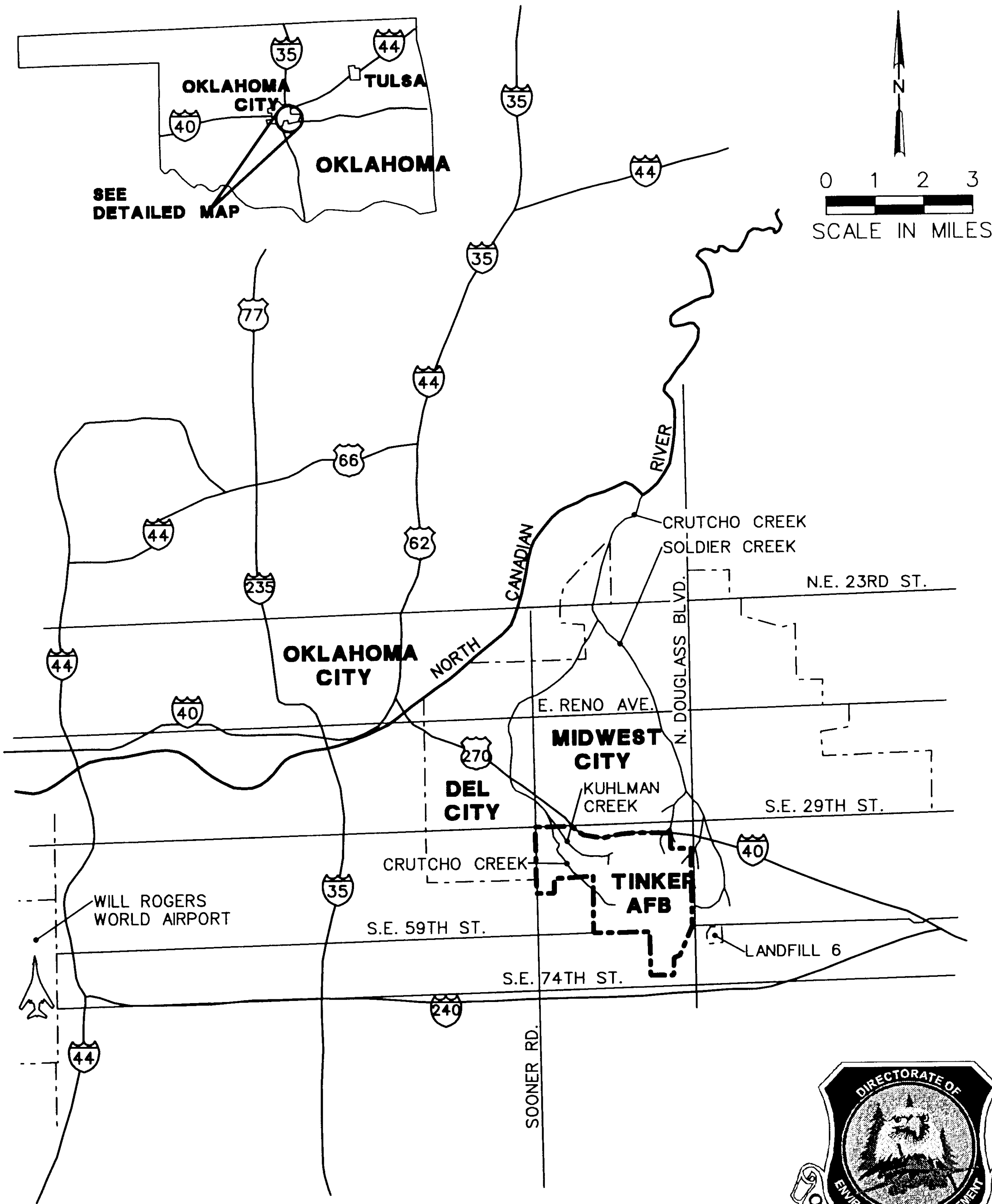
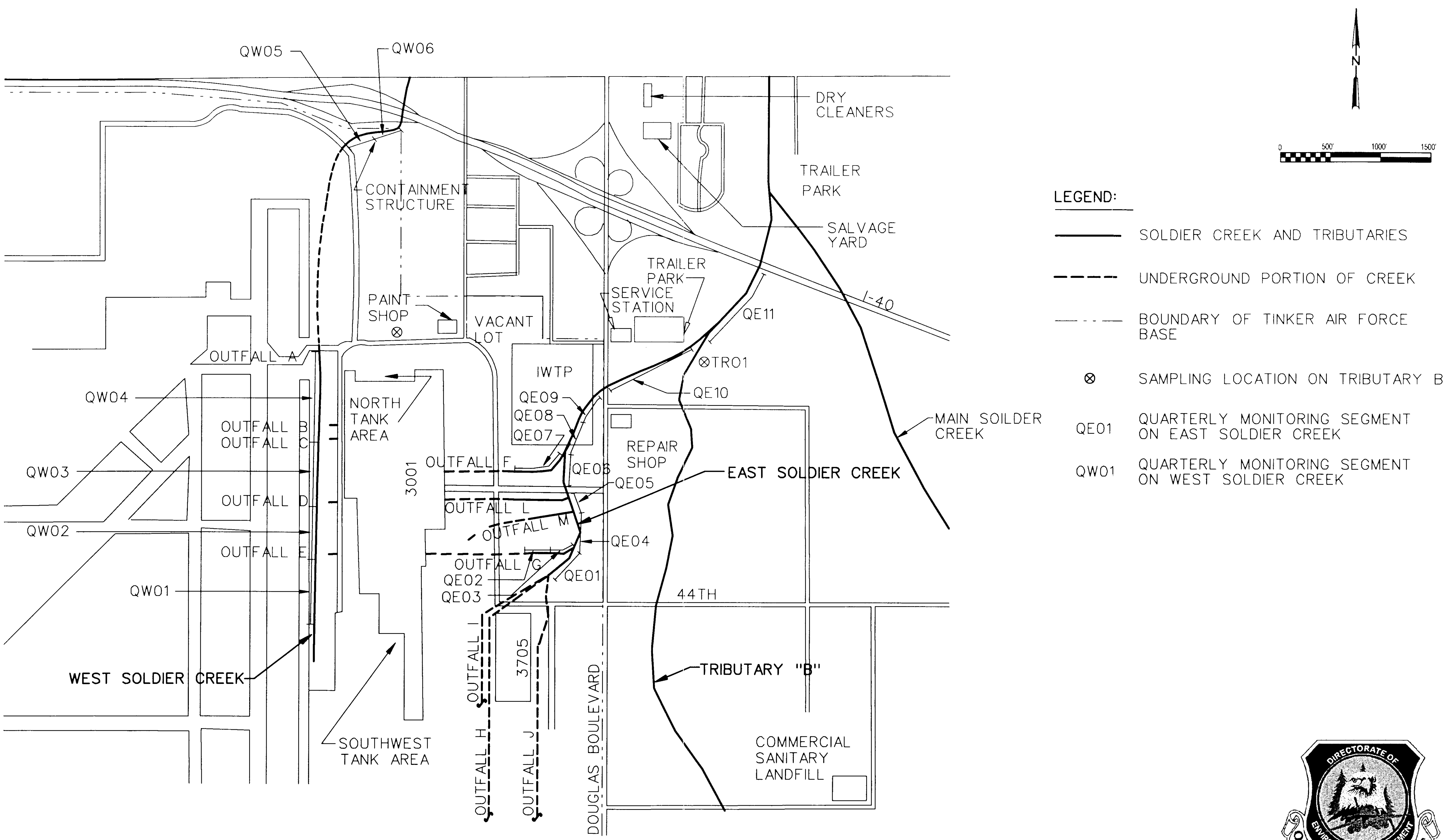


FIGURE 2-1
Tinker Air Force Base Vicinity Map
Tinker Air Force Base, Oklahoma City, Oklahoma



DIRECTORATE OF ENVIRONMENTAL MANAGEMENT OKLAHOMA CITY ALC

FIGURE 2-2
Quarterly Monitoring Sampling Segments
Tinker Air Force Base, Oklahoma City, Oklahoma
October 1998

3. INVESTIGATION METHODS

3.1 Sampling Locations and Labeling

During the fourth year of the long-term monitoring program, sampling frequency occurred semi-annually the segments identified in Figure 2-2. On-base sampling segments included four segments along West Soldier Creek (QW01-QW04), and nine segments along East Soldier Creek (QE01-QE09), and a sample location on a tributary or drainage ditch to West Soldier Creek (QW07). The additional sampling location (QW07) was added to a tributary or drainage ditch to West Soldier Creek during the second quarter of the second year sampling event. The sample location, QW07, is located at the culvert on the northeast corner of the Building 3001 north parking lot, north of Industrial Boulevard. On-base sampling along West Soldier Creek (QW01-QW04) occurred only during the 1Evnt4Yr monitoring event. Excavation and concrete lining of the on-base portion of the channel in July, 1998 precluded sampling during the 2Evnt4Yr monitoring event.

The off-base portion of Soldier Creek bounded by I-40 has been split into four segments, two on West Soldier Creek (QW05, QW06), two on East Soldier Creek (QE10, QE11) and a sample location on Tributary B (TR01), just above the confluence with East Soldier Creek, east of Douglas Boulevard. Stream segments were established based on the locations of known outfalls and structures (i.e., spill containment structures), known or suspected areas of contamination, stream morphology, and in conjunction with Tinker AFB EM personnel familiar with the project (WCFS, 1994). Table 3-1 presents the boundaries for each stream segment.

Sampling occurred quarterly for the first two years of long-term monitoring. Each stream segment was divided into quarters (sections). During each quarterly event, a different section of the stream segment was sampled progressing from upstream the first quarter to downstream with each subsequent event (Figure 3-1). The rationale for sub-dividing the stream segments into sections was to better characterize Soldier Creek surface water and sediment quality temporally and spatially. This sampling methodology was set forth in the ROD (B&V, 1993b).

Locations for semi-annual sampling were based on results from the first two years of quarterly monitoring for each segment of stream. Using sediment concentrations of PAHs as a guide (since they consistently exceed BHRA 10^{-6} screening criteria), the two most contaminated sample locations from each stream segment were selected for sampling during semi-annual monitoring. In the event that PAHs did not exceed the health criteria, best professional judgment was used to determine which locations to sample based on other contaminant concentrations (i.e., PCB concentrations in the second and third quarter segments of QE03). If a segment was "equally" contaminated or there were no significant differences in contamination, the first and third quarter sections of a segment were selected for sampling. During the 1Evnt4Yr monitoring event, the upstream most section of each segment was sampled, and during the 2Evnt4Yr monitoring event, the downstream most section of each segment was sampled.

Data presented in the First Event Third Year Sampling Report (WCFS, 1997d) indicated QE11 would be sampled at the third quarter location during each second semi-annual monitoring event, however, the location could not be positively identified in the field. Therefore, QE11 was sampled at the fourth quarter sampling location, at the I-40 bridge, during the 2Evnt3Yr and 2Evnt4Yr monitoring events. Two additional exceptions to the above described sample location rationale were at Tributary B and QW07, where the same location was sampled during all sampling events. Due to the grade of QW07, sufficient water for sampling was available only near the outlet of the outfall. Table 3-2 presents the quarterly monitoring locations as they correlate to the fourth year (semi-annual) monitoring locations. Figure 3-2 illustrates the sample locations within each sampling segment for semi-annual monitoring.

Samples were collected from a representative location along the stream channel. Sample locations within the section of the stream segment being sampled were determined in the field. Basic criteria for determining a representative sample location included flow, depth, deposition, occurrence of discolored sediments, and change in stream morphology.

3.1.1 Sediment Sampling

Depending on the water column depth and sediment characteristics, a trowel, ponar dredge, or hand auger was used to collect sediment samples. Stainless steel trowels were used to collect samples from the 0-6 inch interval. In areas where the water column was too deep to use a trowel, a stainless steel hand auger was used. Sediment samples obtained from 6-12 inches and 3-5 feet were also collected using a stainless steel hand auger.

For discrete sample collection using the trowel, the sampling area was first cleared of vegetation and/or debris. The sample was collected from the upper 6 inches. Upon reaching the surface, the sample was placed in a stainless steel bowl or on a clean sheet of aluminum foil. The sample for volatile and semi-volatile analyses was placed immediately into sample containers. Free water obtained during sample collection was used to eliminate headspace in the volatile and semi-volatile sample containers. The remaining portion of the sediment sample was composited and then transferred to the appropriate containers based upon analysis to be performed. Any remaining free water from the sample collection was returned to the stream. To the extent practical, the sample hole was backfilled with native sediment and vegetation.

For deeper samples, the hand auger sampler was lowered to the sediment surface and manually augured to the desired sampling depth or to refusal of the device. Upon reaching the surface, the sample was placed on a clean sheet of aluminum foil. The sample for volatile and semi-volatile analyses was placed immediately into sample containers. Free water obtained during sample collection was used to eliminate headspace in the volatile and semi-volatile sample containers. The remaining portion of the sample was composited and then transferred to the appropriate containers based upon analysis to be performed. Any remaining free water from the sample collection was returned to the stream. To the extent practical, the sample hole was backfilled with native sediment and vegetation.

3.1.2 Surface Water Sampling

Surface water samples were collected prior to sediment sampling and were obtained from the same location as sediment samples. Care was taken not to disturb the sediments during sampling. When possible, high velocity areas were avoided due to increased volatilization in turbulent waters. Stagnant waters were unavoidable in many segments due to the intermittent nature of the streams. Grab surface water samples were collected by submerging glass or stainless steel sampling devices directly into the creek. The opening of the container faced upstream. The water was then transferred directly into the sample containers and submitted for laboratory analysis.

Analysis of field parameters was conducted on surface water samples. These parameters included pH, specific conductance, temperature, and dissolved oxygen. Field measurements were recorded on field sheets. A total of four replicates were measured and averaged for each parameter. Volumetric stream flow in each segment was estimated by determining the cross-sectional area and measuring current velocities across a representative transect in accordance with USGS flow-measurement techniques (wading method) (USGS, 1984).

3.1.3 Sample Identification

Each sample was identified by a specific field identification number which indicates site name, sampling location, sample type, and sequence number. An example of the sample identification number *SC-QE01-SD-1201* is as follows:

- SC - indicates the site name (Soldier Creek Sediment and Surface Water Operable Unit)
- QE01..QE11 - indicates sample segment on East Soldier Creek
- QW01..QW07 - indicates sample segment on West Soldier Creek
- TR01 - indicates the sample location on Tributary B
- SW - indicates surface water
- SD - indicates sediment

The last three or four-digit code is the sequence identifier. For the first nine monitoring events, the first digit of the sequence identifier indicates the event being sampled and the sample location within a stream segment (i.e., 1XX through 9XX for sampling events 1 through 9). Subsequent events are indicated by the first two digits of the sequence identifier (i.e., 12XX for the 2Evnt4Yr monitoring event). The last two digits indicate, in sequence, the samples taken from each location. The last two digits always begin with 01 at each location. Duplicate samples for each sampling event were identified by adding 500 to the sequence identifier of the corresponding sample (i.e., SC-QE01-SD-1201 duplicate would be identified as SC-QE01-SD-1701).

In the above example, 1201 indicates the first sample (i.e., 0-6 inches) taken during the 2Evnt4Yr monitoring event, and 1202 indicates the second sample (i.e., 6-12 inches), taken during the 2Evnt4Yr monitoring event.

3.2 Analytical Parameters

Samples were analyzed for volatile organics, semi-volatile organics, metals, polychlorinated biphenyl's (PCBs), and pesticides. Surface water samples were also analyzed for the following wet chemistry parameters: alkalinity, chemical oxygen demand, hardness, total dissolved solids, total organic carbon, total suspended solids, chloride, and sulfate. Dissolved metals analysis was performed on surface water samples during the first event fourth year (1Evnt4Yr) monitoring event. Hexavalent chromium analysis was performed on sediment (0-6 inch bgs) and surface water samples during the 1Evnt4Yr monitoring event. Surface water measurements performed in the field included temperature, pH, conductivity, dissolved oxygen, and flow.

Table 3-3 presents a list of analytes by method and reporting limits. Actual sediment reporting limits were raised due to percent moisture in the sediment and elevated analyte concentrations. A summary of the constituents for analysis, containers, preservation, and holding times are presented in Table 3-4.

Southwell Analytical Laboratories, Oklahoma City, Oklahoma, performed hexavalent chromium analysis for the 1Evnt4Yr monitoring event. Quanterra Environmental Services of Arvada, Colorado performed all remaining analysis.

3.3 Decontamination Procedures

All sampling equipment was decontaminated prior to each sampling location and prior to initial use. Decontamination of equipment minimized the risk of cross-contamination to environmental samples from improperly cleaned sampling equipment and ensured that representative samples were obtained. Tinker AFB provided potable water for all decontamination activities.

Equipment used in the cleaning or decontamination of field equipment included:

- Methanol, reagent grade
- Aluminum foil
- Disposable gloves
- Teflon and stainless steel squeeze bottles or sprayers
- Wash tubs of various sizes and scrub brushes
- Potable water
- High Performance Liquid Chromatography (HPLC) water
- Plastic sheeting
- Washwater containment tubs or containers

Equipment decontamination procedures that were employed in the Soldier Creek investigation are as follows:

- Only Teflon and stainless steel containers were used to dispense water, methanol, or other cleaning agents. No plastic containers were used.
- All personnel performing decontamination procedures wore appropriate protective clothing such as disposable gloves, rubber boots, etc., as specified by the Site Safety Officer.
- All decontamination waste fluids were collected in containers with secondary containment and were stored at the drum staging area until disposal.
- All surface water and sediment sampling equipment (e.g. stainless steel bowls, trowels, dredges, and samplers) was decontaminated using brushes and a laboratory-grade detergent/potable water solution, followed by a potable water rinse, a pesticide-grade methanol rinse, and a HPLC water rinse. All equipment was allowed to air dry before sampling. If not immediately used, all decontaminated sampling equipment was wrapped in aluminum foil before storage or reuse.

All cleaning or wash buckets or tubs were cleaned using laboratory grade detergent/potable water solution and potable water rinse upon mobilization and demobilization.

3.4 Quality Control - Quality Assurance

Quality Assurance (QA) procedures were performed in general accordance with the Quality Assurance Project Plan (QAPP) of the Workplan (WCFS, 1994). No deviations from the QAPP occurred in the field during the long-term monitoring events, with the exception of the rate of QA sample collection. QA was collected at a rate of approximately 10 percent (i.e., 1 for every 10 samples) during the first two years of monitoring. Field duplicates, matrix spikes, and matrix spike duplicates were collected at a rate of approximately 5 percent (i.e., 1 for every 20 samples).

One rinsate was collected for each day of sampling. These Quality Assurance/Quality Control (QA/QC) samples were collected to assess field sampling procedures (including decontamination) and field collection precision. Trip blank samples accompanied each cooler with samples for VOC analysis to assess potential cross-contamination. One field ambient blank for each monitoring event was collected by pouring HPLC water, used for decontamination of equipment and rinsate samples, directly into sample bottles. The ambient blank sample was collected to assess the effects of background conditions, potential sample container contamination, and the quality of the HPLC water.

Quanterra laboratory performed a QA/QC review. A QA/QC data assessment was performed by CH2M HILL which included full validation of at least twenty percent of the data, for each monitoring event, using the SW-846 methods (EPA, 1992b) and the EPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic and Inorganic Data Review (Guidelines) (USEPA, 1994a, 1994b). Data assessment is herein defined as the systematic, structured process of evaluating, editing, screening, checking, verifying, and reviewing to assure that analytical data are in compliance with established criteria and are valid for the intended use.

The full validation consisted of a review of SW-846 results summary sheets and instrument reports for QA/QC parameters such as matrix spikes (MS), matrix spike duplicates (MSDs), detection limits, calibrations, duplicate control samples (DCS), single control samples (SCS), chain of custody forms, sample preparations, holding times, etc. In addition, the review consisted of recalculating laboratory data and standard calibration curves, checking for transcription errors, and carefully checking chromatograms and reconstructed ion chromatograms. The purpose of the full validation is to evaluate whether laboratory performance and analytical data are in compliance with method requirements and project specifications for accuracy, precision, validity, and completeness.

The data assessment process provides information on analytical limitations of data based on regulatory or method specific QA/QC criteria. In addition, the review process assigns data qualifiers and provides a statement concerning usability of data. To ensure the data gathered during the investigation activities are adequate; precision, accuracy, representativeness, completeness, and comparability (PARCC) parameter targets have been identified for Level III analyses during the development of Data Quality Objectives (DQOs) and planning of the field activities. Level III analyses included all laboratory analyses using EPA methods. Quality of the analytical data is indicated by the calculation of values for precision, accuracy, and completeness. The quantitative target values for precision, accuracy, and completeness are as follows:

- Precision = 20 percent
- Accuracy = control limits specified for the particular analysis
- Completeness = 90 percent

Comparability and representativeness are assessed in a qualitative evaluation of the data generated during the field investigation.

The data generated during the fourth year of monitoring at Soldier Creek, Tinker AFB were reviewed as described above. The data were evaluated to be usable as received from Quanterra and Southwell analytical with the qualifications noted in the validation reports for their stated and intended purpose. Complete results of data validation and signed Chain of Custody Forms are presented in the monitoring reports (WCFS, 1998c and CH2M HILL, 1998)

TABLES

TABLE 3-1
LONG-TERM MONITORING STREAM SEGMENT BOUNDARIES

WEST SOLDIER CREEK ON-BASE PORTION	
Section 1 (QW01)	South Tank Area to Outfall E
Section 2 (QW02)	Outfall E to just above Outfall D
Section 3 (QW03)	Outfall D to just above Outfall C
Section 4 (QW04)	Outfall C to culvert opposite north end of Building 3001, where on-base above ground portion of West Soldier Creek ends.
Section 5 (QW07)	Single location located on tributary to West Soldier Creek at emergence from north-east corner of parking lot, north of Building 3001 .

WEST SOLDIER CREEK OFF-BASE PORTION	
Section 1 (QW05)	Above-ground reach from it's emergence at three culverts near Tinker Gate 7 to the spill containment structure
Section 2 (QW06)	Spill containment structure to Interstate 40

EAST SOLDIER CREEK ON-BASE PORTION	
Section 1 (QE01)	Mainstem from its emergence at 44th Street to just above the confluence of Outfall G
Section 2 (QE02)	Outfall G from its emergence east, half way to its confluence with the mainstem
Section 3 (QE03)	Outfall G from halfway to its confluence with the mainstem to the mainstem.
Section 4 (QE04)	Mainstem from Outfall G to just above the confluence of Outfall M
Section 5 (QE05)	Outfall M to Bradley Drive
Section 6 (QE06)	The long pool from Bradley Drive north to just above Outfall F
Section 7 (QE07)	Outfall F from its emergence to its confluence with the mainstem
Section 8 (QE08)	The mainstem from Outfall F to the dam on the mainstem
Section 9 (QE09)	The mainstem from the dam to the spill containment structure on Douglas Blvd.

EAST SOLDIER CREEK OFF-BASE PORTION	
Section 1 (QE10)	The mainstem from Douglas Boulevard to just above the confluence with Tributary B
Section 2 (QE11)	The mainstem from Tributary B to Interstate 40

TABLE 3-2
SEMI-ANNUAL MONITORING
SAMPLE LOCATIONS

Segment	First Event	Second Event
WEST SOLDIER CREEK		
QW01	1st Quarter Location - 100 feet downstream from southwest end of South Tank Area	NA
QW02	1st Quarter Location - 60 feet downstream from Outfall E	NA
QW03	1st Quarter Location - 75 feet downstream from Outfall D	NA
QW04	3rd Quarter Location - 380 feet downstream from Outfall C	NA
QW05	1st Quarter Location - 30 feet downstream of culverts	3rd Quarter Location - Approx. 75 feet upstream from spill containment structure
QW06	1st Quarter Location - pool below spill containment structure	3rd Quarter Location - 50 feet upstream from spill containment structure
QW07	1st Quarter Location - 1 foot (water) and 5 feet (sediment) from culvert opening	1st Quarter Location - 1 foot (water) and 5 feet (sediment) from culvert opening
EAST SOLDIER CREEK		
QE01	1st Quarter Location - 18 feet upstream from 1st weir, below outfalls H, I, J	4th Quarter Location - on main branch of East Soldier Creek, 5-10 feet upstream of confluence with Outfall G
QE02	3rd Quarter Location - 4 feet upstream from 2nd weir, downstream from culvert, on Outfall G	4th Quarter Location - Just above 3rd weir located downstream from culvert on Outfall G
QE03	1st Quarter Location - 10 feet downstream from third weir, downstream from culvert, on Outfall G. Sediment collected from constriction below pool.	2nd Quarter Location - 5 feet above fourth weir located downstream from culvert on Outfall G
QE04	1st Quarter Location - Approximately 40 feet downstream from confluence with Outfall G, on East Soldier Creek. Collected adjacent to a northern plane (sycamore) tree.	3rd Quarter Location - In pool, just above weir located upstream of Bradley Drive, on East Soldier Creek

TABLE 3-2
SEMI-ANNUAL MONITORING
SAMPLE LOCATIONS

Segment	First Event	Second Event
QE05	1st Quarter Location - 1 feet downstream from confluence with Outfall M, on East Soldier Creek. Upsteam of spill gate at Bradley Drive.	2nd Quarter Location - 10 feet south of Bradley Drive spill containment structure on East Soldier Creek
QE06	3rd Quarter Location - Perpendicular to red fence post on east bank of pond. Approximately 750 feet upstream of confluence of East Soldier Creek and Outfall F.	4th Quarter Location - Approx. 35 upstream of confluence with Outfall F, on East Soldier Creek pond
QE07	1st Quarter Location - At uppermost weir in top pool of Outfall F	3rd Quarter Location - 10-15 feet above 3rd weir located downstream from culvert on Outfall F
QE08	2nd Quarter Location - In middle of pond, between confluence with Outfall F, and dam.	3rd Quarter Location - center of pond, perpendicular to storm water outfall. Approximately 150 feet upstream of dam
QE09	1st Quarter Location - 20 feet downstream of dam, on eastern banch of creek. Upstream from IWTP NPDES outfall.	3rd Quarter Location - approximately 5 feet downstream of IWTP outfall in east side channel
QE10	1st Quarter Location - 175 feet downstream from Douglas Boulevard.	3rd Quarter Location - midway between northern/western property line of white house and confluence of East Soldier Creek with Tributary B
QE11	1st Quarter Location - 125 feet downstream from confluence with Tributary B, on East Soldier Creek	4th Quarter Location - Approx. 25 feet upstream from I-40 bridge
Trib B	1st Quarter Location - 12 feet upstream of confluence with East Soldier Creek in drainage ditch known as Tributary B	1st Quarter Location - 12 feet upstream of confluence with East Soldier Creek in drainage ditch known as Tributary B

Note: * The second event location for QE11 was originally identified as the third quarter sampling location. The location could not be positively identified in the field and was sampled at the fourth quarter location, at the I-40 bridge.

TABLE 3-3
ANALYTES AND REPORTING LIMITS

Analytes	Sediment[1]	Water
Recoverable Metals - Method 6010/6020		
Aluminum	10*	15
Antimony	6*	3
Barium	1*	1
Beryllium	0.2*	0.5
Cadmium	0.5*	0.3
Calcium	20*	200*
Chromium	1*	5
Cobalt	1*	0.5
Copper	2*	2
Iron	10*	100*
Lead	5*	1
Magnesium	20*	200*
Manganese	1*	0.2
Molybdenum	2*	1
Nickel	4*	0.2
Potassium	500*	5000*
Silver	1*	0.5
Sodium	500*	5000*
Thallium	200*	0.1
Vanadium	1*	0.5
Zinc	-	10
Selenium	0.5	5
Metals - Methods As(7060), Hg(7470/7471), Hexavalent Chromium (7196A)	**mg/kg**	**mg/L**
Arsenic	0.5	0.005
Mercury	.033	0.0002
Selenium	0.5	-
Hexavalent Chromium[2]	2.5	0.1
PCB's and Chlorinated Pesticides - Method 8080	**mg/kg**	**ug/L**
4,4'-DDD	3.3	0.01
4,4'-DDE	3.3	0.01
4,4'-DDT	3.3	0.01
Aldrin	1.7	0.005
alpha-BHC	1.7	0.005
alpha-Chlordane	1.7	0.005
Aroclor 1016	33	0.1
Aroclor 1221	33	0.1
Aroclor 1232	33	0.1
Aroclor 1242	33	0.1
Aroclor 1248	33	0.1

TABLE 3-3
ANALYTES AND REPORTING LIMITS

Analytes	Sediment[1]	Water
Aroclor 1254	33	0.1
Aroclor 1260	33	0.1
beta-BHC	1.7	0.005
delta-BHC	1.7	0.005
Dieldrin	3.3	0.01
Endosulfan I	1.7	0.005
Endosulfan II	3.3	0.01
Endosulfan sulfate	3.3	0.01
Endrin	3.3	0.01
gamma-BHC (Lindane)	1.7	0.005
gamma-Chlordane	1.7	0.005
Heptachlor	1.7	0.005
Heptachlor epoxide	1.7	0.005
Methoxychlor	17	0.05
Toxaphene	170	0.25
Volatile Organics - Method 8240/8260	**mg/kg**	**ug/L**
Acetone	10	10
Acrolein	100	100
Acrylonitrile	100	100
Benzene	5	5
Bromodichloromethane	5	5
Bromoform	5	5
Bromomethane	10	10
2-Butanone (MEK)	10	10
Carbon disulfide	5	5
Carbon tetrachloride	5	5
Chlorobenzene	5	5
Chloroethane	10	10
Chloroform	5	5
Chloromethane	10	10
Dibromochloromethane	5	5
Dibromomethane	5	5
trans-1,4-Dichloro-2-butene	5	5
Dichlorodifluoromethane	20	20
1,1-Dichloroethane	5	5
1,2-Dichloroethane	5	5
1,1-Dichloroethene	5	5
1,2-Dichloropropane	5	5
cis-1,3-Dichloropropene	5	5
trans-1,3-Dichloropropene	5	5
Ethylbenzene	5	5
Ethyl methacrylate	20	20
Iodomethane	5	5
2-Hexanone	10	10

TABLE 3-3
ANALYTES AND REPORTING LIMITS

Analytes	Sediment[1]	Water
Methylene chloride	5	5
4-Methyl-2-pentanone (MIBK)	10	10
Styrene	5	5
1,1,1,2-Tetrachloroethane	5	5
1,1,2,2-Tetrachloroethane	5	5
Tetrachloroethene	5	5
Toluene	5	5
1,1,1-Trichloroethane	5	5
1,1,2-Trichloroethane	5	5
Trichlorethene	5	5
Trichlorofluoromethane	5	5
1,2,3-Trichloropropane	5	5
Vinyl acetate	10	10
Vinyl chloride	10	10
Xylenes (total)	5	5
trans 1,2-Dichloroethene	5	5
Ethanol	--	--
2-Chlorethyl vinyl ether	10	10
Semivolatile Organics - Method 8270	**mg/kg**	**ug/L**
Acenaphthene	330	10
Acenaphthylene	330	10
Acetophenone	330	10
4-Aminobiphenyl	330	10
Aniline	330	10
Anthracene	330	10
Benzo(a)anthracene	330	10
Benzo(b)fluoranthene	330	10
Benzo(k)fluoranthene	330	10
Benzo(g,h,i)perylene	330	10
Benzo(a)pyrene	330	10
Benzyl alcohol	330	10
4-Bromophenyl phenyl ether	330	10
Butyl benzyl phthalate	330	10
4-Chloroaniline	330	10
bis(2-Chloroethoxy)methane	330	10
bis(2-Chloroethyl)ether	330	10
bis(2-Chloroisopropyl)ether/2,2'-oxybis (1 chloropropane)	330	10
4-Chloro-3-methylphenol	330	10
2-Chloronaphthalene	330	10
2-Chlorophenol	330	10
4-Chlorophenyl phenyl ether	330	10
Chrysene	330	10
Dibenz(a,h,)anthracene	330	10

TABLE 3-3
ANALYTES AND REPORTING LIMITS

Analytes	Sediment[1]	Water
Dibenzofuran	330	10
Di-n-butyl phthalate	330	10
1,2-Dichlorobenzene	330	10
1,3-Dichlorobenzene	330	10
1,4-Dichlorobenzene	330	10
3,3'-Dichlorobenzidine	660	20
2,4-Dichlorophenol	330	10
2,6-Dichlorophenol	330	10
Diethyl phthalate	330	10
p-Dimethylaminoazobenzene	330	10
7,12-Dimethylbenz(a)-anthracene	330	10
a,a-Dimethylphenethyl-amine	330	10
2,4-Dimethylphenol	330	10
Dimethyl phthalate	330	10
4,6-Dinitro-2-methylphenol	1600	50
2,4-Dinitrophenol	1600	50
2,4-Dinitrotoluene	330	10
2,6-Dinitrotoluene	330	10
Di-n-octyl phthalate	330	10
Diphenylamine	330	10
bis(2-Ethylhexyl)phthalate	330	10
Ethyl methanesulfonate	330	10
Fluoranthene	330	10
Fluorene	330	10
Hexachlorobenzene	330	10
Hexachlorobutadiene	330	10
Hexachlorocyclopentadiene	330	10
Hexachloroethane	330	10
Indeno(1,2,3-cd)pyrene	330	10
Isophorone	330	10
3-Methylcholanthrene	330	10
Methyl methanesulfonate	330	10
2-Methylnaphthalene	330	10
2-Methylphenol	330	10
3/4-Methylphenol	330	10
Naphthalene	330	10
1-Naphthylamine	330	10
2-Naphthylamine	330	10
3-Nitroaniline	1600	50
4-Nitroaniline	1600	50
Nitrobenzene	330	10
2-Nitrophenol	330	10
4-Nitrophenol	1600	10
N-Nitroso-di-n-butylamine	330	10
N-Nitrosodiphenylamine	330	10

TABLE 3-3
ANALYTES AND REPORTING LIMITS

Analytes	Sediment[1]	Water
N-Nitroso-di-n-propylamine	330	10
N-Nitrosopiperidine	330	10
Pentachlorobenzene	330	10
Pentachloronitrobenzene	1600	10
Pentachlorophenol	1600	10
Phenacetin	330	10
Phenanthrene	330	10
Phenol	330	10
2-Picoline	330	10
Pronamide	330	10
Pyrene	330	10
1,2,4,5-Tetrachloro-benzene	330	10
2,3,4,6-Tetrachlorophenol	1600	50
1,2,4-Trichlorobenzene	330	10
2,4,5-Trichlorophenol	1600	50
2,4,6-Trichlorophenol	330	10
Benzidine	2500	50
1-Chloronaphthalene	2500	50
Dibenz(a,j)acridine	--	--
Azobenzene	2500	50
Benzoic acid	2500	50
Wet Chemistry	**mg/kg**	**mg/L**
Hardness	NA	5
COD	NA	20
TOC	NA	1.0
TSS	NA	2
TDS	NA	10
ALK	NA	5
Chloride	NA	0.5
Sulfate	NA	0.5

NA - Not applicable

* Indicates Method 6010, all other metals by Method 6020

[1] Actual sediment reporting limits vary due to percent moisture, and preparation dilution

[2] Reporting units for sediment & surface hexavalent chromium analysis for second and third quarters second year monitoring were 20 mg/kg and 0.5 mg/L, respectively.

TABLE 3-4
ANALYTES, CONTAINERS, PRESERVATION, AND HOLDING TIMES

MEDIA	METHOD	PARAMETER	CONTAINER	PRESERVATION	HOLDING TIME
Sediment	SW-486 8240/8260	Volatile Organics	Two 4 oz. wide-mouthed jars	4° C	14 days
Sediment	SW-846 8270	Semivolatile Organics	*16 oz. wide-mouthed jars	4° C	14 days to extraction 40 days to analysis
Sediment	SW-846 8080	Pesticides (with PCB's)	*16 oz. wide-mouthed jars	4° C	14 days to extraction 40 days to analysis
Sediment	SW-846 6010/6020/7000	Metals	*16 oz. wide-mouthed jars	4° C	180 days Hg - 28 days
Sediment	7196	Hexavalent Chromium	4 oz. wide mouth jar	4° C	24 hours
Water	SW-846 8240	Volatile Organics	Three 40-ml. glass vial w/Teflon cap	4° C HCl pH<2	14 days
Water	SW-846 8270	Semivolatile Organics	Two 32oz glass (amber)	4° C	7 days to extraction 40 days to analysis
Water	SW-846 8080	Pesticides (with PCB's)	Two 32oz glass (amber)	4° C	7 days to extraction 40 days to analysis
Water	SW-846 6010//6020/7060/7470	Total Metals, As, Hg	One 500-ml plastic bottle**	HNO_3 pH<2	180 days Hg - 28 days
Water	6010/6020	Dissolved Metals	One 500-ml plastic bottle**	HNO_3 pH<2	180 days Hg - 28 days
Water	130.2	Hardness	One 500-ml plastic bottle**	HNO_3 pH<2	180 days
Water	410.4, 415.1	Chemical Oxygen Demand / Total Organic Carbon	One 16-oz glass	4° C H_2SO_4 pH<2	COD 24 days, TOC 28 days
Water	160.1, 160.2, 310.1, 300.0	Total Suspended Solids, Total Dissolved Solids, Alkalinity, Chloride, Sulfate	Two 500-ml plastic bottles	4° C	TSS 7 days, TDS 7 days, Alkalinity 14 days, Chloride 14 days, Sulfate 28 days
Water	7196	Hexavalent Chromium	One liter amber	4° C	24 hours

*One 16oz glass container filled is sufficient for metals, semivolatile organics, and pesticides & PCB sediment analysis
**One 500-ml bottle is sufficient for total metals, As, Hg, and hardness analysis

FIGURES

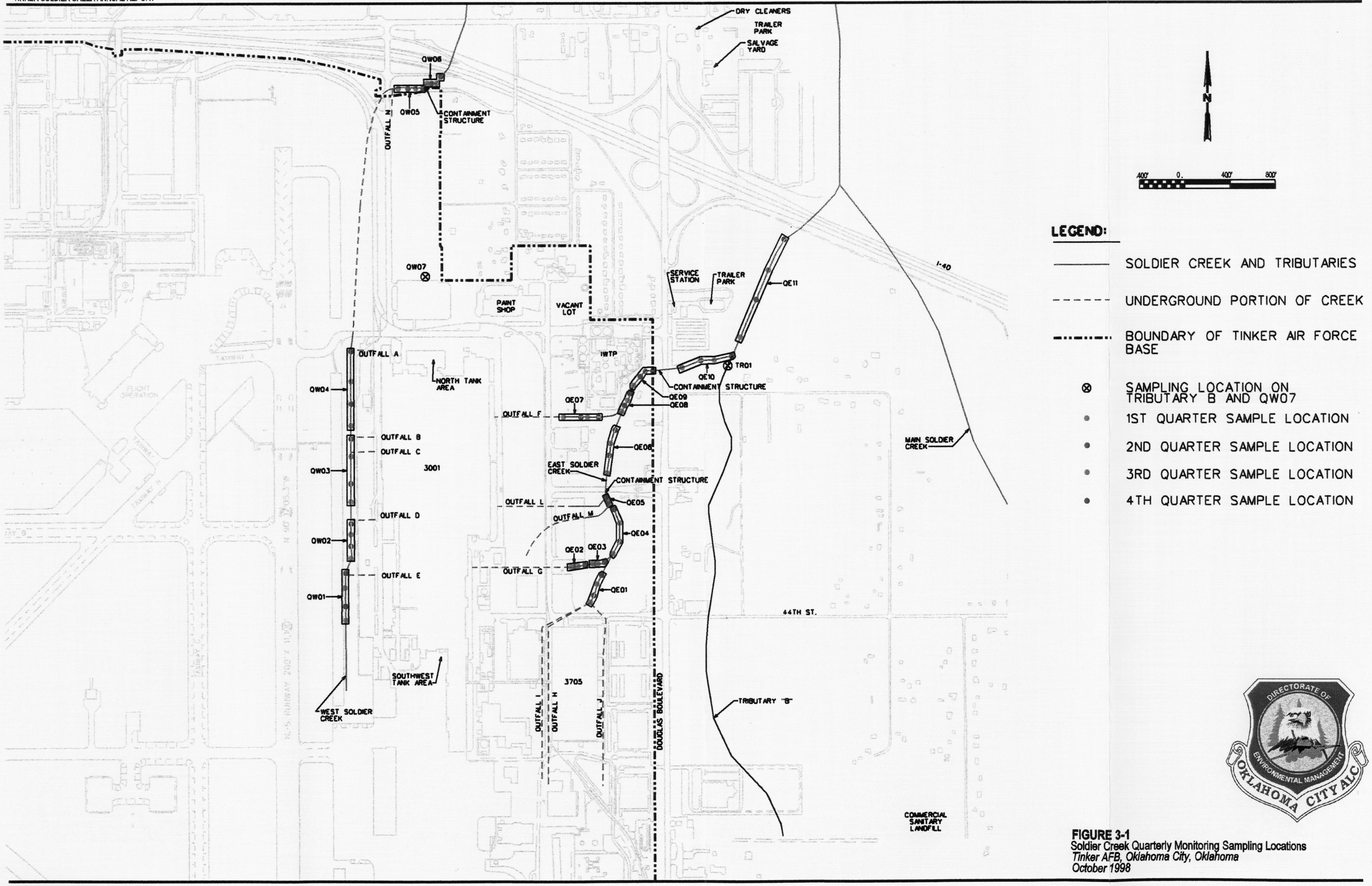
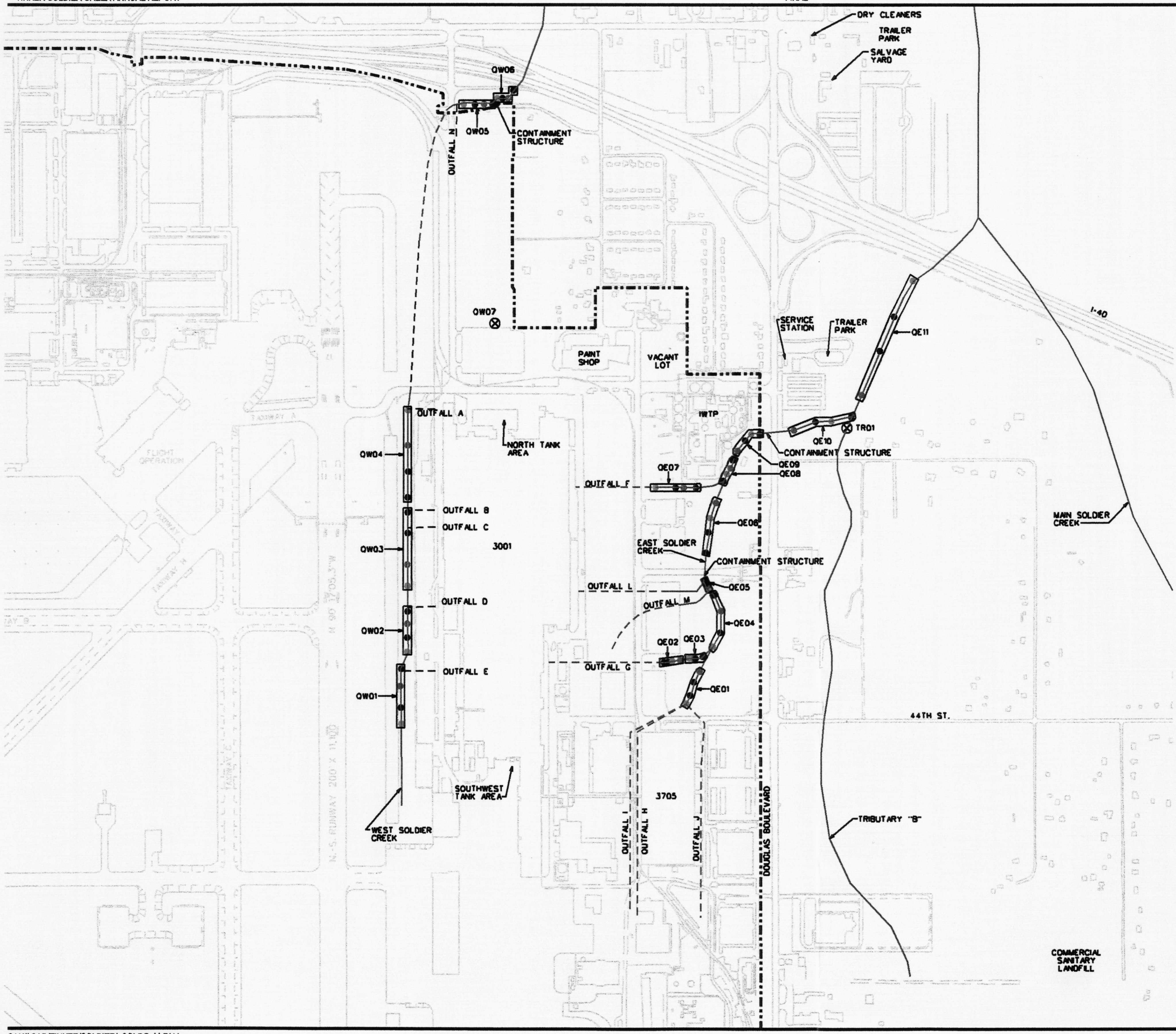


FIGURE 3-1
Soldier Creek Quarterly Monitoring Sampling Locations
Tinker AFB, Oklahoma City, Oklahoma
October 1998



LEGEND:

———	SOLDIER CREEK AND TRIBUTARIES
- - - -	UNDERGROUND PORTION OF CREEK
-··-··-	BOUNDARY OF TINKER AIR FORCE BASE
⊗	SAMPLING LOCATION ON TRIBUTARY B AND QW07
•	1ST SEMI-ANNUAL MONITORING EVENT SAMPLE LOCATION
•	2nd SEMI-ANNUAL MONITORING EVENT SAMPLE LOCATION
•	QUARTERLY SAMPLE LOCATIONS NOT SAMPLED DURING SEMI-ANNUAL MONITORING

DIRECTORATE OF ENVIRONMENTAL MANAGEMENT
OKLAHOMA CITY ALC

FIGURE 3-2
Semi-Annual Monitoring Sampling Locations
Tinker AFB, Oklahoma City, Oklahoma
October 1998

4. HUMAN HEALTH RISK ASSESSMENT

Results of the human health risk assessment IV (HHRA IV) of Soldier Creek surface water and sediment at Tinker Air Force Base (AFB), Oklahoma City, Oklahoma are presented in Appendix A of this document. This section is presented to summarize the HHRA IV.

Soldier Creek surface water and sediment are sampled semi-annually as part of long-term monitoring of Soldier Creek. Previously, Black & Veatch Waste Science Technology (B&V 1993c) and Woodward-Clyde Federal Services (1997a, 1997b, 1998c) evaluated potential risks associated with Soldier Creek surface water and sediment using data available at the time of their assessments. This human health RA evaluates the potential current and future risks associated with Soldier Creek surface water and sediment based on the most recently measured surface water and sediment concentrations (January and July 1998 semi-annual Soldier Creek monitoring). The results from this current assessment were compared with the results from the three previous WCFS RAs (WCFS 1997a, 1997b, 1998a) to determine if the earlier conclusions are still valid and if there are any trends associated with the calculated risks. Additionally, remediation goals protective of human health developed by WCFS (1999a) for surface water and sediment were updated in this report.

This RA incorporates the methodology described in the *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A* (RAGS; USEPA 1989a), *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part B* (USEPA 1991b), *Exposure Factors Handbook* (USEPA 1989b), *Standard Default Exposure Factors* (USEPA 1991a), *Dermal Exposure Assessment: Principles and Applications* (USEPA 1992a), and *Supplemental Region IV Risk Assessment Guidance* (USEPA 1996). Toxicity data were obtained from USEPA's Integrated Risk Information System (IRIS; USEPA 1998a), Health Effects Assessment Summary Tables (HEAST; USEPA 1997), and USEPA Region III's Risk-based Concentration Table (USEPA 1998b). Surface water and sediment data collected from Soldier Creek during the January and July 1998 semi-annual monitoring were evaluated.

Soldier Creek was divided into three different areas for analysis in the RA based on different contaminant sources and exposed populations. The three segments are:

- Off-Base West Soldier Creek
- On-base East Soldier Creek
- Off-Base East Soldier Creek

Tinker AFB began remediation of the on-base portion of West Soldier Creek in July 1998. This remediation includes excavating sediment and lining the channel with concrete. Consequently, surface water and sediment samples were not collected from the area of the on-base segment of West Soldier Creek undergoing remediation during July 1998 and a risk evaluation was not conducted for the on-base segment of West Soldier Creek.

An evaluation of potential human health risks was performed for surface water and sediment in the three stream segments for the chemicals of potential concern (COPCs). The COPCs identified for the different stream segments include metals, polychlorinated biphenyls (PCBs), pesticides, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). Exposure scenarios believed to represent potential human activities in the stream segments were evaluated. These exposure scenarios were developed in the previous RAs and for consistency were evaluated in this assessment. The exposure scenarios evaluated include:

- Construction workers involved in repair or installation of underground pipelines around or under on-base portions of East Soldier Creek; and
- Residents wading or swimming in off-Base portions of West and East Soldier Creeks.

Based on the depth of water, swimming was only evaluated for the residential child scenario for off-Base East Soldier Creek; all other scenarios assume wading only. Exposure to both surface water and sediment was evaluated for all receptors.

Potential cancer risks are below or within the USEPA recommended range of 10^{-6} to 10^{-4} and potential noncarcinogenic hazards are below the USEPA recommended noncarcinogenic health hazard of 1.0 for all scenarios. These results indicate that exposure to surface water and sediment in West and East Soldier Creeks is not likely to result in an unacceptable cancer risk or noncarcinogenic hazard for on-base or off-base populations under current or future stream use and current environmental conditions.

The results of the current risk analysis were compared to the results from the three previous HHRAs. It should be noted that the methodology used in the current risk analysis was slightly different than the methodology used in the three previous HHRAs. The 1996 USEPA Region IV Supplemental Risk Guidance (USEPA 1996) was followed for this assessment and the 1991 USEPA Region IV Guidance (USEPA 1991d) was followed for the previous assessments. The largest difference between the current and the previous HHRAs was the methodology used to select the COPCs, which resulted in different COPCs being selected. Therefore, the risk assessments are not completely comparable. In general, no dramatic changes between the first three WCFS HHRAs and the current (fourth year) HHRA IV were identified. Therefore, no definitive statement can be made regarding trends for East and West Soldier Creeks based on these results. The differences in estimated noncarcinogenic hazards and carcinogenic risks are due to changes in contaminant concentrations and the chemicals that were detected in the sediment and surface water. These differences are expected because the stream is a dynamic system affected by factors such as precipitation levels. Effluent outfall flow and concentrations also impact the dynamics of the stream system. Like heavy precipitation, large volumes of effluent outfall may dilute concentrations in the stream system. Therefore, it is possible for concentrations in the stream to rise despite the closure of outfalls. The differences between the HHRA IV and the three previous HHRAs may also be attributed to the use of a different method to select the COPCs for quantitative evaluation in the HHRA.

To date, none of the HHRAs indicated any unacceptable adverse noncarcinogenic health effects or cancer risks associated with exposure to West or East Soldier Creeks for any on-base or off-base population under current or future stream use conditions. Consequently, no remedial action is necessary based on risks to human health. As part of the HHRA, health-protective cleanup goals were developed for each COPC. Although remediation is not currently warranted based on risk to human health, the cleanup goals provide a set of "action criteria" should remediation be required in the future.

5. DISCUSSION OF MONITORING RESULTS

This section discusses data screening and evaluation procedures and the results of the fourth year of sediment and surface water long-term monitoring of the Soldier Creek Operable Unit.

5.1 Data Screening

The purpose of data screening and analysis was to determine which analytes are present and which of those exceed media specific screening criteria. For this assessment, a simple two step procedure was used. The first step was to establish the presence or absence of analytes in the sediment and surface water samples. All analytes reported in detectable concentrations were tabulated on a segment by segment basis for each monitoring event.

The second step involved sample by sample comparisons to screening criteria. Screening criteria were set forth in the ROD (B&V, 1993b) and the HHRA I (WCFS, 1997a). These screening criteria are risk-based values to which specific analyte concentrations are compared. If sample concentrations were below the decision criteria, it was assumed that the analyte does not pose an unacceptable risk to human health and response actions are not required. Therefore, the analyte was dropped from further consideration. If screening criteria were exceeded, the analyte was considered a potential COC.

According to the ROD (B&V, 1993b), unacceptable exposures were determined based on the following criteria:

- Contaminant concentrations in sediment or surface water exceeding health levels based on an excess lifetime cancer risk of 10^{-4}. Contaminant concentrations detected in the 10^{-4} to 10^{-6} range may potentially indicate an unacceptable exposure level and will be evaluated to determine if the exposure level was unacceptable and remediation, therefore, necessary.
- Contaminant concentrations in sediment or surface water with non-carcinogenic hazard indices (HIs) greater than 1.0
- Contaminant concentrations in sediment or surface water that present an unacceptable ecological risk

The first two criteria were based on exposure factors developed by the BHRA for human health under the RI/FS, and the HHRA I. Summaries of carcinogenic and non-carcinogenic risks for contaminants of concern in sediment and surface water from the BHRA are presented in Table 5-1 and Table 5-2. Risk based cleanup levels developed by the HHRA I and for sediment and surface water are presented in Tables 5-3 through 5-4. The following evaluation and discussion of analytical results is for the fourth year long-term monitoring results. These results were screened against the BHRA and HHRA I screening criteria as described above. The fourth year analytical results were also evaluated under the HHRA IV for unacceptable cancer risk or non-carcinogenic hazard presented in Appendix A.

5.2 Evaluation and Discussion of Results

5.2.1 Sediment

A total of 63 sediment samples (35 during 1Evnt4Yr and 28 during 2Evnt4Yr) were collected during the fourth year of long-term monitoring. Sediment samples were generally collected at three intervals from 0-6 inches, 6-12 inches, and 3-5 feet. Samples from TR01 were only collected from 0-6 inches, per the scope of work. When refusal of the sampling device occurred prior to 5 feet bgs, a sample was typically collected from the bottom one foot interval of the boring. The number of sediment samples collected varied each event based on the depth of sediment at each sampling location. In some sampling segments, particularly on-base East Soldier Creek, upstream of Bradley Drive, the stream bed is scoured to bedrock with few, shallow depositional areas.

Appendix B contains tables which summarize the analyte detections by monitoring event. Table 5-5 presents the frequency of detection, maximum, minimum and average concentrations of analytes detected in sediment. Statistical summaries were calculated based on detected concentrations in analytical samples excluding non-detects and QA/QC samples. The sample location at which the maximum concentration of an analyte was detected is presented in Table 5-6. Table 5-7 presents a summary of analytes for 0-6 inches and 6-12 inches bgs for the first four years of long-term monitoring which exceeded the BHRA screening criteria. Analytes which exceeded HHRA I 10^{-5} and 10^{-6} carcinogenic screening criteria during the first four years of long-term monitoring are presented in Table 5-8 and Table 5-9. No analytes in sediment samples exceeded the HHRA I 10^{-4} carcinogenic or non-carcinogenic screening criteria. Table 5-10 presents a comparison of the maximum analyte concentration for each event of the first four years of long-term monitoring to the maximum RI sampling analytical results.

Metals

Twenty-four metals were detected during the fourth year of monitoring. Metals detected by Methods 6010 and 7471 were: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

The most frequently detected metals and their maximum concentrations were aluminum (16,300 mg/kg), arsenic (12.2 mg/kg), barium (4,550 mg/kg), calcium (184,000 mg/kg), chromium (1,830 mg/kg), cobalt (78.3), copper (1,390 mg/kg), iron (27,000 mg/kg), magnesium (17,900 mg/kg), manganese (5,370 mg/kg), nickel (3,590 mg/kg), potassium (2,580 mg/kg), vanadium (92.2 mg/kg), and zinc (924 mg/kg). These metals were detected in all 63 sediment samples collected during the fourth year of monitoring. Metals concentrations in sediment did not exceed BHRA or HHRA I screening criteria.

PCB's and Chlorinated Pesticides

4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, aroclor 1254, delta-BHC, endosulfan II, and gamma-chlordane were detected in the sediments during the fourth year of monitoring.

Pesticides and PCBs were not identified as potential COPC in the BHRA (B&V, 1993a). Consequently, screening criteria were not available from the BHRA for evaluation. HHRA I

10^{-6} and non-carcinogenic screening criteria for PCBs and pesticides were not exceeded during the fourth year of monitoring.

Aroclor 1254 was the most frequently detected PCB/pesticide compound with 18 detections in sediment samples. The highest concentration of PCB's and pesticides was also Aroclor 1254 which was detected in QE02-SD-1101 at 13,000 ug/kg.

Semivolatile Organics

Thirty-five semivolatile organic compounds (SVOCs) were detected during the fourth year of monitoring. The SVOCs detected during the fourth year of monitoring are presented in Table 5-5.

The highest semivolatile concentration was fluoranthene (160 mg/kg) which occurred in QE07-1101 during the 1Evnt4Yr monitoring. Fluoranthene was detected in 46 sediment samples. The average concentration for fluoranthene during the fourth year of monitoring was 9.93 mg/kg.

Six semivolatile analytes were identified as potential contaminants of concern by exceeding risk-based screening criteria during the fourth year of monitoring. Benzidine was identified as a potential contaminant of concern during the first year of monitoring. However, benzidine concentrations did not exceed the screening criteria during the second, third or fourth years of monitoring. Indeno(1,2,3-cd)pyrene was identified as a potential contaminant of concern during the second or fourth years of monitoring by exceeding HHRA 10^{-6} screening criteria.

The polyaromatic hydrocarbons (PAHs) benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and chrysene, exceeded the BHRA screening criteria during both fourth year monitoring events (Table 5-7). Benzo(a)pyrene and dibenz(a,h,)anthracene exceeded the HHRA 10^{-5} screening criteria (Table 5-8). Benzo(a)-pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene exceeded the HHRA I 10^{-6} screening criteria (Table 5-9).

Benzo(a)anthracene was detected in 39 analytical samples, 13 of which exceeded BHRA 10^{-6} screening criteria of 1.6 mg/kg, and 2 of which exceeded HHRA I 10^{-6} of 10.575 mg/kg. The highest concentration of benzo(a)anthracene was 46 mg/kg detected in sample QE07-SD-1101. The sample was collected during 1Evnt4Yr monitoring from 0-6 inches. The average detected concentration of benzo(a)anthracene during the fourth year of monitoring was 3.57 mg/kg.

Benzo(b)fluoranthene was detected in 38 analytical samples, 15 of which exceeded BHRA 10^{-6} screening criteria of 1.6 mg/kg and 3 of which exceeded HHRA I 10^{-6} screening criteria of 10.575 mg/kg. The highest concentration of benzo(b)fluoranthene was 55 mg/kg detected in sample QE07-SD-1101, collected from Outfall F. The sample was collected during 1Evnt4Yr monitoring from 0-6 inches. The average detected concentration of benzo(b)fluoranthene during the fourth year of monitoring was 4.17 mg/kg.

Benzo(k)fluoranthene was detected in 39 analytical samples, 14 of which exceeded BHRA 10^{-6} screening criteria of 1.6 mg/kg. Benzo(k)fluoranthene concentrations did not exceed HHRA I screening criteria. The highest concentration of benzo(k)fluoranthene was 59 mg/kg detected in sample QE07-SD-1101, collected from Outfall F. The sample was collected the during 1Evnt4Yr monitoring from 0-6 inches. The average detected concentration of benzo(k)fluoranthene during the fourth year of quarterly monitoring was 3.72 mg/kg.

Benzo(a)pyrene was detected in 41 analytical samples, 14 of which exceeded BHRA 10^{-6} screening criteria of 1.6 mg/kg, 2 of which exceeded HHRA I 10^{-5} screening criteria of 10.575 mg/kg, and 19 of which exceeded HHRA I 10^{-6} screening criteria of 1.057 mg/kg. The highest concentration of benzo(a)pyrene was 63 mg/kg detected in sample QE07-SD-1101, collected from Outfall F. The sample was collected during 1Evnt4Yr monitoring from 0-6 inches. The average detected concentration of benzo(a)pyrene during the fourth year of monitoring was 4.02 mg/kg.

Chrysene was detected in 40 analytical samples, 17 of which exceeded BHRA 10^{-6} screening criteria of 1.6 mg/kg. Chrysene concentrations did not exceed HHRA I screening criteria. The highest concentration of chrysene was 66 mg/kg detected in sample QE07-SD-1101, collected from Outfall F. The sample was collected during 1Evnt4Yr monitoring from 0-6 inches. The average detected concentrations of chrysene during the fourth year of monitoring was 4.83 mg/kg.

Dibenz(a,h)anthracene was detected in 24 analytical samples, 6 of which exceeded the HHRA I 10^{-6} screening criteria of 1.057 mg/kg, and 2 of which exceeded the HHRA I 10^{-5} screening criteria of 10.575 mg/kg. Dibenz(a,h)anthracene did not exceed BHRA screening criteria. The highest concentration of dibenz(a,h)anthracene was 15 mg/kg detected in sample QE07-1101, collected from Outfall F. The sample was collected during 1Evnt4Yr monitoring from 0-6 inches. The average detected concentration of dibenz(a,h)anthracene during the fourth year of monitoring was 1.61 mg/kg.

Figure 5-1 illustrates the sample locations where exceedances of BHRA 10^{-6} screening criteria occurred in 0-6 inch sediment samples, during the fourth year of monitoring. Figures 5-2a through 5-2n present graphs of temporal PAH concentrations by stream segment for the first four years of monitoring. The graphs illustrate the sediment concentrations at 0-6 inches for the five PAHs which exceeded BHRA screening criteria in every sampling event (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene). Graphs are presented only for those segments in which exceedance of the BHRA PAH screening criteria occurred during the first, second, third and/or fourth years of monitoring (QE01-QE10, and QW02-QW05). The graphs illustrate that typically the detected PAH concentrations follow the same trend (e.g., an increase in one PAH compound is associated with increases in the other detected PAH compounds).

The graphs also illustrate that the sampling event with the highest concentration of the PAHs varies between the sampling segments. This relationship suggests that multiple origins for the PAHs could exist. For example, during the second year of monitoring many of the highest PAH concentrations occurred in segment QE03 (Outfall G). However, during the third and fourth years of monitoring many of the highest PAH concentrations occurred in segment QE07 (Outfall F).

The following discussion presents a summary of peak discharges, and possible trends in the PAH data observed in Figure 5-2a through 5-2n over the first four years of monitoring. The summary presented below is relevant to BHRA screening criteria and analyte concentrations in sediments 0-6 inches bgs.

- QE01 shows the highest PAH concentrations occurred during the 1Qtr1Yr, 1Qtr2Yr, and 4Qtr2Yr monitoring events. PAH concentrations did not exceed screening criteria during the fourth year of monitoring.

- QE02 and QE03 show no apparent trends from the first to second year monitoring among quarters. At QE03, PAH concentrations peaked during the 2Qtr2Yr monitoring event. At QE02, two peaks in PAH concentrations occurred, during the 3Qtr1Yr, and 4Qtr2Yr monitoring events. PAH concentrations during the third and fourth years of monitoring remained relatively low. Sediments along Outfall G are shallow in most locations. The peaks in location may be also related to the availability of depositional sediments. Although peaks from QE02 and QE03 do not occur during the same monitoring events, peaks may be related to spill events, and the depositional characteristics of each sample location.

- QE04 showed a peak concentration of PAHs during the 3Qtr1Yr monitoring event. Sediments at QE04 consist of large smooth gravel. Depositional sediment is not present in this stream segment. PAH concentrations did not exceed BHRA screening criteria during the third or fourth years of monitoring.

- QE05 showed a spike in PAH concentrations during the 4Qtr1Yr monitoring events. PAH concentrations did not exceed BHRA screening criteria during the third or fourth years of monitoring.

- QE06 shows the highest PAH concentrations at the third and fourth quarter sample locations during the first two years of monitoring. During the third year of monitoring, PAH concentrations peaked during the first monitoring event (equivalent to the third quarter location), and decreased during the second monitoring event (fourth quarter location). The concentrations decreased from the first to second year of monitoring, increased during the third year monitoring, and decreased again during fourth year monitoring. The sediments at these sample locations are highly organic, and the creek is marshy.

- QE07 shows peak concentrations during the 1Qtr2Yr and 1Evnt4Yr monitoring events. PAH concentrations peaked during the first monitoring event (first quarter location), and decreased during the second monitoring event (third quarter location) during the third year of monitoring. During the third and fourth years of monitoring, the highest concentrations of benzo(b)fluoranthene, benzo(a)pyrene, and chrysene were detected in segment QE07 during the 1Evnt3Yr and 1Evnt4Yr monitoring events.

- QE08 shows the highest PAH concentrations occurred at the third quarter sample location during the first two years of monitoring. During the third and fourth years of monitoring, the highest concentrations of PAHs detected in segment QE08 during the 2Evnt3Yr and 2Evnt4Yr monitoring events (third quarter location).

- QE09 PAH concentrations did not exceed screening criteria until the 2Evnt3Yr monitoring event (third quarter location). The exceedance only occurred for chrysene. During the fourth year of monitoring, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene exceeded screening criteria.
- QE10 PAH concentrations only exceeded screening criteria during the 4Qtr1Yr monitoring event. Prior to and since that time, PAH concentrations have been very low.
- QW02 and QW03 peak PAH concentrations occurred during the 1Qtr2Yr sampling event.
- QW04 peak PAH concentrations occurred during the 3Qtr2Yr monitoring event.
- QW05 PAH concentrations peaked, and exceeded screening criteria during the 1Qtr1Yr, 3Qtr1Yr, and 1Evnt3Yr (first quarter location) monitoring events. PAH concentrations were very low during the second year of monitoring. During the fourth year of monitoring, the highest concentrations of PAHs were detected in segment QW05 during the 1Evnt4Yr monitoring event.

Figures 5-3a through 5-3j present the upstream to downstream concentration gradient of PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene) in 0-6 inch bgs sediment samples by event for East Soldier Creek. Similarly, Figures 5-4 a through 5-4j present the upstream to downstream concentration gradient of PAHs in 0-6 inch bgs sediment samples for West Soldier Creek.

The figures illustrate that concentrations of analytes decrease off-base as compared to on-base. Exceedances of 10^{-6} screening criteria (BHRA and HHRA I) have occurred during the 3Qtr1Yr and 1Evnt3Yr monitoring events on an off-base portion of West Soldier Creek (QW05). Exceedances of 10^{-6} screening criteria (BHRA) have occurred during the 4Qtr1Yr monitoring event on a off-base portion of East Soldier Creek (QE10). Analytical results from the downstream most segments of both East and West Soldier Creek (QE11, and QW06) did not exceed BHRA or HHRA I screening criteria during any sampling event.

The primary source of release of PAHs to the environment occurs as a result of combustion emissions. Discharges may also occur from spills of fuel oils, gasoline, etc., or from runoff from sources such as roadways, asphalt parking lots, or railroad ties.

Volatiles

Thirteen volatile compounds (VOCs) were detected in sediment samples during the fourth year of monitoring. The VOCs detected during the fourth year of monitoring are presented in Table 5-5. Volatile concentrations in sediment did not exceed BHRA or HHRA I screening criteria.

The most frequently detected volatile compound was acetone. Acetone was detected in 51 analytical samples with a maximum concentration of 0.57 mg/kg and average concentration of 0.047 mg/kg. The highest concentration of acetone was detected in the sediment sample from QE09-SD-1202, collected from below the pond on East Soldier Creek. The sample was collected during 2Evnt4Yr monitoring from 6-12 inches.

5.2.2 Surface Water

A total of 30 (16 during 1Evnt4Yr and 14 during 2Evnt4Yr) surface water samples were collected during the fourth year of monitoring. The number of surface water samples varied each event due to the intermittent nature of the streams. Sample locations at segments QW01, through QW04, were not sampled during the second event due to the excavation and concrete lining of the channel. The sample location at Tributary B was dry during both monitoring events.

Appendix B contains tables, which summarize analyte detections by monitoring event. Table 5-11 presents the frequency of detection, maximum, minimum, and average concentrations of analytes detected in surface water samples. Statistical summaries were calculated based on detected concentrations in analytical samples excluding detections in QA/QC samples and non-detects. The sample location at which the maximum concentration of an analyte was detected is presented in Table 5-12. Table 5-13 presents a comparison of maximum analyte concentrations of the surface water samples for each monitoring event of the first four years of monitoring to the maximum RI analytical results.

Metals

Twenty-four total metals were detected during the fourth year of monitoring. Total metals detected in surface water by Method 6010/6020/7740 were: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

The most frequently detected total metals and their maximum concentrations were aluminum (0.88 mg/L), barium (0.52 mg/L), calcium (62.9 mg/L), chromium (0.025 mg/L), cobalt (0.00089 mg/L), copper (0.14 mg/L), iron (1.2 mg/L), magnesium (26.5 mg/L), manganese (0.16 mg/L), molybdenum (0.011 mg/L), nickel (0.036 mg/L), potassium (4.7 mg/L), selenium (0.0039 mg/L), sodium (36.3 mg/L), vanadium (0.016 mg/L), and zinc (0.079 mg/L). These metals were detected in all 30 surface water samples collected during the fourth year of monitoring.

The highest total metal concentration was calcium (62.9 mg/L) from sample QW07-SW-1201. The sample was collected during the 2Evnt4Yr monitoring. The average concentration of calcium from the fourth year of monitoring was 46.63 mg/L.

Twenty dissolved metals were detected during the 1Evnt4Yr monitoring. Dissolved metals detected in surface water by Method 6010/6020 were: aluminum, antimony, barium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, vanadium, and zinc.

The most frequently detected dissolved metals and their maximum concentrations were barium (0.42 mg/L), calcium (69.2 mg/L), chromium (0.025 mg/L), cobalt (0.00058 mg/L), copper (0.061 mg/L), magnesium (26.4 mg/L), manganese (0.14 mg/L), nickel (0.33 mg/L), selenium (0.0033 mg/L), sodium (26.4 mg/L), vanadium (0.017 mg/L), and zinc (0.065 mg/L). These metals were detected in all 16 surface water samples collected during 1Evnt4Yr monitoring.

The highest dissolved metal concentration was calcium (69.2 mg/L) from sample QW07-SW-1101. The sample was collected during 1Evnt4Yr monitoring. The average concentration of dissolved calcium from the fourth year of monitoring was 53.11 mg/L.

Total arsenic was reported as 0.0061 mg/L in sample QW06-SW-1201, collected during the 2Evnt4Yr monitoring. The reported value exceeds the HHRA I 10^{-6} screening criteria of 0.0044 mg/L. Arsenic was also detected in the associated laboratory blank and the result was qualified as non-detect (ND). Therefore, no total or dissolved metals concentrations exceeded BHRA or HHRA I screening criteria in surface water samples during the fourth year of monitoring.

PCBs and Chlorinated Pesticides

Dieldrin and Heptachlor were detected in surface water during the fourth year of monitoring. Dieldrin was detected in one surface water sample at QE07-SW-1201 (0.029 ug/L), collected from Outfall F. The sample was collected during 2Evnt4Yr monitoring. Heptachlor was detected in one surface water sample at QE07-SW-1201 (0.024 ug/L), collected from Outfall F. The sample was also collected during 2Evnt4Yr monitoring.

PCB and pesticide concentrations did not exceed BHRA or HHRA I risk based screening criteria in surface water.

Semivolatiles

Bis(2-Ethylhexyl)phthalate and Di-n-butyl phthalate were detected in surface water during the fourth year of monitoring. Bis(2-Ethylhexyl)phthalate was detected in four surface water samples. The maximum concentration of bis(2-Ethylhexyl)phthalate (0.14 mg/L) occurred at QE02-SW-1201, collected from Outfall G during 2Evnt4Yr monitoring. This sample exceeded the HHRA I 10^{-6} screening criteria of 0.0967 mg/L for bis(2-Ethylhexyl)phthalate The average detected concentration of bis(2-Ethylhexyl)phthalate during the fourth year of monitoring was 0.037 mg/L.

Volatiles

Four VOCs were detected in surface water during the fourth year of monitoring. The VOCs detected during the fourth year of monitoring are acetone, bromoform, methylene chloride, and tetrachloroethene.

The highest VOC concentration was acetone (0.0051 mg/L) detected in sample QW07-SW-1101. This sample was collected during 1Evnt4Yr monitoring. The average surface water concentration of acetone detected during the fourth year of monitoring was 0.0028 mg/L.

Methylene chloride was the most frequently detected VOC, being reported in 21 surface water samples. The highest concentration of methylene chloride was 0.0031 mg/L detected in sample QW04-SW-1101, collected from on-base West Soldier Creek during 1Evnt4Yr monitoring. The average surface water concentration of methylene chloride detected during the fourth year of monitoring was 0.0017 mg/L.

Volatiles concentrations in surface water did not exceed BHRA or HHRA I risk based screening criteria.

Wet Chemistry

Surface water samples were analyzed for the following wet chemistry parameters: alkalinity, chemical oxygen demand, hardness, total dissolved solids, total organic carbon, total suspended solids, chloride, and sulfate. Results of wet chemistry analysis are presented in Table B-7 and Table B-8 in Appendix B.

TABLES

TABLE 5-1
CARCINOGENIC AND NON-CARCINOGENIC
BASELINE HEALTH RISK ASSESSMENT (BHRA) SCREENING CRITERIA FOR SEDIMENT

Compound Name	Non-Caracinogenic	Carcinogenic 10-6	Carcinogenic 10-4
Inorganics (mg/kg)			
Arsenic	2.10E+06		
Mercury	6.20E+05		
Barium	1.40E+08		
Cadmium	1.00E+06		
Chromium	1.00E+07		
Manganese	2.10E+08		
Nickel	4.10E+07		
Silver	6.20E+06		
Vanadium	1.40E+07		
Zinc	4.10E+08		
Semivolatile Organics (ug/kg)			
1,2-Dichlorobenzene	7.90E+08		
1,4-Dichlorobenzene		1.00E+06	1.00E+08
2,4-Dimethylphenol	1.80E+08		
2-Methylphenol	4.40E+08		
3/4-Methylphenol	4.40E+08		
Acenaphthene	3.80E+07		
Anthracene	1.90E+08		
Benzo(a)anthracene		1.60E+03	1.60E+05
Benzo(a)pyrene		1.60E+03	1.60E+05
Benzo(b)fluoranthene		1.60E+03	1.60E+05
Benzo(k)fluoranthene		1.60E+03	1.60E+05
bis(2-Ethylhexyl)^phthalate	1.30E+07	1.00E+05	1.00E+07
Butyl benzyl phthalate	1.30E+08		
Chrysene		1.60E+03	1.60E+05
Dibenz(a,h)anthracene		1.20E+05	1.20E+07
Fluoranthene	2.50E+07		
Fluorene	2.50E+07		
Indeno(1,2,3-cd)pyrene		1.20E+05	1.20E+07
Naphthalene	2.50E+06		
Pyrene	1.90E+07		
Volatile Organics (ug/kg)			
Acetone	4.10E+07		
Benzene		3.30E+04	3.30E+06
Carbon disulfide	5.70E+08		
Chlorobenzene	8.30E+06		
Chloroform	4.10E+06	1.60E+05	1.60E+07
cis-1,2-Dichloroethene			
Ethylbenzene	5.70E+08		
Methylene chloride	2.50E+07	1.30E+05	1.30E+07
Tetrachloroethene	4.10E+06	1.90E+04	1.90E+06
Toluene	8.30E+07		
trans-1,2-Dichloroethene			
Trichloroethene		1.40E+06	1.40E+08
Vinyl acetate	5.70E+09		
Xylenes (total)	8.30E+08		

TABLE 5-2
CARCINOGENIC AND NON-CARCINOGENIC
BASELINE HEALTH RISK ASSESSMENT (BHRA) SCREENING CRITERIA FOR SURFACE WATER

Compound Name	Non-Caracinogenic	Carcinogenic 10-6	Carcinogenic 10-4
Inorganics (mg/L)			
Arsenic	8.10E+00		
Barium	2.50E+02		
Beryllium	1.50E+02		
Cadmium	2.10E+00		
Chromium	1.10E+01		
Manganese	3.50E+02		
Nickel	6.20E+01		
Silver	3.50E+02		
Vanadium	5.60E+02		
Zinc	1.30E+03		
Semivolatile Organics (ug/L)			
Benzoic acid	1.00E+05		
Chrysene		1.20E+03	1.20E+05
Fluoranthene	2.20E+04		
Pyrene	5.90E+06		
Volatile Organics (ug/L)			
1,1,1-Trichloroethane	1.10E+05		
Acetone	5.00E+05		
Benzene		2.00E+01	2.00E+03
Bromodichloromethane	8.40E+05	1.70E+03	1.70E+05
Bromoform	1.90E+06	3.30E+04	3.30E+06
Carbon disulfide	5.30E+03		
Chlorobenzene	1.30E+04		
Chloroform	2.00E+04	7.60E+02	7.60E+04
cis-1,2-Dichloroethene			
Dibromochloromethane	1.30E+06	2.00E+03	2.00E+05
Methylene chloride	1.70E+05	8.90E+02	8.90E+04
Tetrachloroethene	5.70E+04	3.10E+02	3.10E+04
Toluene	5.60E+03		
trans-1,2-Dichloroethene			
Trichloroethene		2.80E+02	2.80E+04
Xylenes (total)	1.10E+07		

TABLE 5-3

CARCINOGENIC AND NON-CARCINOGENIC
HUMAN HEALTH RISK ASSESSMENT I (HHRA I) SCREENING CRITERIA FOR SEDIMENT

Chemical	Reasonable Maximum Exposure (mg/kg)	Total Hazard Quotient	Total Cancer Risk	Non-carcinogenic [a] Action Level (mg/kg)	Carcinogenic [b] Action (Risk = 1 x 10^{-6}) (mg/kg)	Carcinogenic [b] Action (Risk = 1 x 10^{-5}) (mg/kg)	Carcinogenic [b] Action (Risk = 1 x 10^{-4}) (mg/kg)
Inorganics							
Antimony	6.42E+00	3.69E-03		1.74E+03			
Beryllium	5.61E-01	2.58E-05	2.38E-07	2.18E+04	2.36E+00	2.36E+01	2.36E+02
Cadmium	1.23E+02	2.83E-02		4.35E+03			
Chromium	7.64E+02	8.94E-06		1.00E+06[c]			
Cobalt	8.22E+00	3.15E-05		2.61E+05			
Lead	1.62E+02						
Mercury	1.64E-01	1.26E-04		1.31E+03			
Nickel	2.09E+02	2.40E-03		8.71E+04			
Silver	4.95E+00	2.28E-04		2.18E+04			
Thallium	1.09E+00	3.13E-03		3.48E+02			
Vanadium	2.03E+01	6.66E-04		3.05E+04			
Pesticides and PCBs							
Aldrin	4.50E-02	4.53E-04	9.91E-08	9.93E+01	4.54E-01	4.54E+00	4.54E+01
alpha-BHC	2.00E-03		1.63E-09		1.23E+00	1.23E+01	1.23E+02
alpha-Chlordane	7.48E-02	3.77E-04	1.26E-08	1.99E+02	5.94E+00	5.94E+01	5.94E+02
Aroclor 1254	1.70E+00	2.57E-02		6.62E+01			
delta-BHC	1.27E-01						
Heptachlor	9.70E-01	5.86E-04	5.65E-07	1.65E+03	1.72E+00	1.72E+01	1.72E+02
Volatiles							
2-Butanone (MEK)	6.66E-03	3.36E-09		1.00E+06[c]			
Acetone	3.98E-02	1.20E-07		3.31E+05			
Acrylonitrile	4.50E-03	4.53E-05	9.91E-09	9.93E+01	4.54E-01	4.54E+00	4.54E+01
Benzene	5.60E-03		1.68E-12		3.33E+03	3.33E+04	3.33E+05
Carbon disulfide	9.47E-03	2.86E-08		3.31E+05			
Chlorobenzene	7.00E-03	1.06E-07		6.62E+04			
Ethylbenzene	1.30E-02	3.77E-09		1.00E+06[c]			
Methylene chloride	6.95E-03	3.50E-08	6.75E-12	1.99E+05	1.03E+03	1.03E+04	1.03E+05
Tetrachloroethene	5.45E-03	1.58E-08		3.45E+05			
Toluene	2.20E-03	3.32E-09		6.62E+05			
trans-1,2-Dichloroethene	1.50E-03	2.27E-08		6.62E+04			
Trichloroethene	1.07E-02	5.16E-08	1.22E-12	2.07E+05	8.79E+03	8.79E+04	8.79E+05
Vinyl chloride	5.66E-03		1.11E-10		5.09E+01	5.09E+02	5.09E+03
Xylenes (total)	3.25E-02	4.71E-10		1.00E+06[c]			
Semivolatiles							
1,2,4-Trichlorobenzene	4.30E-01	8.25E-07		5.21E+05			
1,2-Dichlorobenzene	5.07E-01	1.63E-07		1.00E+06[c]			
1,3-Dichlorobenzene	2.79E+00	9.08E-07		1.00E+06[c]			
1,4-Dichlorobenzene	2.10E-01		5.21E-11		4.03E+03	4.03E+04	4.03E+05
1-Chloronaphthalene	1.30E+00	1.31E-05		9.93E+04			
2,4-Dimethylphenol	3.50E-01	5.07E-07		6.91E+05			

TABLE 5-3

CARCINOGENIC AND NON-CARCINOGENIC
HUMAN HEALTH RISK ASSESSMENT I (HHRA I) SCREENING CRITERIA FOR SEDIMENT

Chemical	Reasonable Maximum Exposure (mg/kg)	Total Hazard Quotient	Total Cancer Risk	Non-carcinogenic [a] Action Level (mg/kg)	Carcinogenic [b] Action (Risk = 1 x 10^{-6}) (mg/kg)	Carcinogenic [b] Action (Risk = 1 x 10^{-5}) (mg/kg)	Carcinogenic [b] Action (Risk = 1 x 10^{-4}) (mg/kg)
2-Chloronaphthalene	6.90E-02	2.61E-07		2.65E+05			
2-Methylnaphthalene	1.10E-01	1.11E-06		9.93E+04			
3/4-Methylphenol	1.60E-01	9.67E-07		1.65E+05			
Acenaphthene	2.41E-01	1.21E-06		1.99E+05			
Acenaphthylene	3.90E+00	3.77E-06		1.00E+06[c]			
Anthracene	7.50E-02	7.56E-08		9.93E+05			
Benzidine	1.19E+01	1.15E-04	2.83E-05	1.04E+05	4.20E-01	4.20E+00	4.20E+01
Benzo(a)anthracene	3.23E+00		3.05E-07		1.06E+01	1.06E+02	1.06E+03
Benzo(a)pyrene	1.52E+00		1.43E-06		1.06E+00	1.06E+01	1.06E+02
Benzo(b)fluoranthene	7.61E-01		7.19E-08		1.06E+01	1.06E+02	1.06E+03
Benzo(g,h,i)perylene	6.00E-01	6.04E-06		9.93E+04			
Benzo(k)fluoranthene	5.51E-01		5.21E-09		1.06E+02	1.06E+03	1.06E+04
Benzoic acid	1.70E-01	1.23E-09		1.00E+06[c]			
bis(2-Ethylhexyl)phthalate	4.90E+00		8.89E-09		5.51E+02	5.51E+03	5.51E+04
Butyl benzyl phthalate	3.70E-01	5.36E-08		1.00E+06[c]			
Chrysene	3.70E+00		3.50E-09		1.06E+03	1.06E+04	1.06E+05
Di-n-butyl phthalate	3.40E-02	1.03E-07		3.31E+05			
Di-n-octyl phthalate	7.70E-02	1.16E-06		6.62E+04			
Dibenz(a,h)anthracene	1.70E-01		1.61E-07		1.06E+00	1.06E+01	1.06E+02
Dibenzofuran	2.13E-01	1.61E-05		1.32E+04			
Dimethyl phthalate	4.50E-02	1.36E-09		1.00E+06[c]			
Fluoranthene	5.30E+00	4.00E-05		1.32E+05			
Fluorene	1.71E+00	1.24E-06		1.00E+06[c]			
Indeno(1,2,3-cd)pyrene	5.38E-01		5.09E-08		1.06E+01	1.06E+02	1.06E+03
Naphthalene	4.50E-01	4.34E-07		1.00E+06[c]			
Phenanthrene	7.27E-01	7.32E-06		9.93E+04			
Phenol	6.30E-02	3.17E-08		1.00E+06[c]			
Pyrene	6.40E+00	6.45E-05		9.93E+04			

Note: a). Action level = (Risk Assessment Conc/HQ) x HI where HI = 1.0

b). Action level = (Risk Assessment Conc/Cancer risk) x Target cancer Risk

c). Calculated action level is greater than 100% concentration and 100% concentration is assigned as the cleanup goal

TABLE 5-4

CARCINOGENIC AND NON-CARCINOGENIC HUMAN HEALTH RISK ASSESSMENT I (HHRA I) SCREENING CRITERIA FOR SURFACE WATER

Chemical	Reasonable Maximum Exposure (mg/L)	Total Hazard Quotient	Total Cancer Risk	Non-carcinogenic [a] Action Level (mg/L)	Carcinogenic [b] Action (Risk = 1 x 10^{-6}) (mg/L)	Carcinogenic [b] Action (Risk = 1 x 10^{-5}) (mg/L)	Carcinogenic [b] Action (Risk = 1 x 10^{-4}) (mg/L)
Inorganics							
Arsenic	1.40E-03	1.65E-03	3.18E-07	8.50E-01	4.41E-03	4.41E-02	4.41E-01
Cadmium	2.64E-03	1.88E-03		1.40E+00			
Cobalt	5.23E-03	3.10E-05		1.68E+02			
Molybdenum	2.64E-01	1.22E-03		2.16E+02			
Nickel	2.99E-02	5.92E-04		5.06E+01			
Thallium	1.20E-03	5.29E-03		2.27E-01			
Vanadium	6.66E-03	3.46E-04		1.92E+01			
Pesticides and PCBs							
Aldrin	5.36E-05	7.82E-04	1.71E-07	6.85E-02	3.13E-04	3.13E-03	3.13E-02
Volatile Organics							
2-Butanone (MEK)	2.80E-03	3.65E-08		7.67E+04			
Acetone	5.30E-03	1.64E-05		3.23E+02			
Bromoform	2.46E-03	9.64E-07	5.44E-11	2.56E+03	4.53E+01	4.53E+02	4.53E+03
Carbon disulfide	1.00E-03	1.60E-08		6.25E+04			
Chlorobenzene	1.80E-03	7.05E-07		2.56E+03			
Chloroform	1.80E-03	1.41E-06	3.07E-11	1.28E+03	5.86E+01	5.86E+02	5.86E+03
Methylene chloride	1.25E-02	6.44E-05	1.24E-08	1.94E+02	1.00E+00	1.00E+01	1.00E+02
Tetrachloroethene	9.79E-03	7.66E-06		1.28E+03			
Toluene	1.70E-03	6.65E-08		2.56E+04			
Trichloroethene	1.00E-02	1.31E-05	3.09E-10	7.67E+02	3.25E+01	3.25E+02	3.25E+03
Vinyl chloride	1.00E-03		5.31E-09		1.88E-01	1.88E+00	1.88E+01
Semivolatile Organics							
3/4-Methylphenol	1.70E-03	9.66E-06		1.76E+02			
4-Nitrophenol	2.00E-03	3.34E-05		5.99E+01			
Benzoic acid	3.90E-03	7.63E-09		5.11E+05			
Benzyl alcohol	1.70E-03	4.44E-08		3.83E+04			
bis(2-Ethylhexyl)phthalate	3.60E-03	3.10E-04	3.72E-08	1.16E+01	9.67E-02	9.67E-01	9.67E+00
Fluoranthene	1.50E-03	2.94E-07		5.11E+03			
N-Nitroso-di-n-propylamine	1.80E-03		3.67E-07		4.91E-03	4.91E-02	4.91E-01
Phenol	1.40E-03	3.12E-07		4.49E+03			

Note: a). Action level = (Risk Assessment Conc/HQ) x HI where HI = 1.0

b). Action level = (Risk Assessment Conc/Cancer risk) x Target cancer Risk

TABLE 5-5
STATISTICAL EVALUATION OF ANALYTES DETECTED IN SEDIMENT SAMPLES
FOURTH YEAR LONG-TERM MONITORING

COMPOUND NAME	NumOfResult	MinOfResult	MaxOfResult	AvgOfResult
PCBs & Pesticides (ug/kg)				
4,4'-DDD	2	5.4	5.7	5.55
4,4'-DDE	1	100	100	100
4,4'-DDT	2	0.92	14	7.46
Aldrin	1	110	110	110
Aroclor 1254	18	25	13000	2846.33
delta-BHC	1	2	2	2
Endosulfan II	2	5.7	590	297.85
gamma-Chlordane	1	25	25	25
Semivolatile Organic Compounds (mg/kg)				
1,2-Dichlorobenzene	6	0.073	11	2.3905
1,3-Dichlorobenzene	2	0.15	1.1	0.625
1,4-Dichlorobenzene	5	0.1	6.3	1.508
1-Chloronaphthalene	9	0.05	38	5.49
2,4-Dimethylphenol	1	0.062	0.062	0.062
2-Chloronaphthalene	7	0.078	0.71	0.27
2-Methylnaphthalene	8	0.043	1.6	0.25625
2-Methylphenol	1	0.083	0.083	0.083
Acenaphthene	18	0.042	2.4	0.66
Acenaphthylene	4	0.048	0.09	0.0625
Acetophenone	1	0.53	0.53	0.53
Anthracene	28	0.048	12	1.43
Azobenzene	1	0.053	0.053	0.053
Benzidine	3	0.089	0.11	0.10
Benzo(a)anthracene	39	0.047	46	3.57
Benzo(a)pyrene	41	0.042	63	4.02
Benzo(b)fluoranthene	38	0.049	55	4.17
Benzo(g,h,i)perylene	39	0.048	60	3.89
Benzo(k)fluoranthene	39	0.052	59	3.72
Benzoic acid	1	1.8	1.8	1.8
bis(2-Ethylhexyl)phthalate	42	0.043	16	2.03052381
Butyl benzyl phthalate	1	0.068	0.068	0.068
Chrysene	40	0.057	66	4.83
Di-n-butyl phthalate	3	0.053	0.47	0.193666667
Di-n-octyl phthalate	2	0.13	0.51	0.32
Dibenz(a,h)anthracene	24	0.074	15	1.614
Dibenz(a,j)acridine	4	0.085	0.94	0.371
Dibenzofuran	11	0.15	1.4	0.463636364
Fluoranthene	46	0.044	160	9.93
Fluorene	20	0.049	4.2	0.82615
Indeno(1,2,3-cd)pyrene	39	0.05	49	3.32
Naphthalene	20	0.044	9.4	1.71

TABLE 5-5
STATISTICAL EVALUATION OF ANALYTES DETECTED IN SEDIMENT SAMPLES
FOURTH YEAR LONG-TERM MONITORING

COMPOUND NAME	NumOfResult	MinOfResult	MaxOfResult	AvgOfResult
Phenanthrene	39	0.054	70	5.53
Phenol	2	0.046	0.086	0.066
Pyrene	44	0.042	120	7.50
Total Metals (mg/kg)				
Aluminum	63	545	16300	5161.67
Antimony	13	2.5	7.4	4.2
Arsenic	63	0.28	12.2	2.65
Barium	63	34.7	4550	552.03
Beryllium	53	0.14	1.2	0.50
Cadmium	51	0.35	291	29.80
Calcium	63	914	184000	27092.78
Chromium	63	2.2	1830	191.33
Cobalt	63	1.3	78.3	7.67
Copper	63	1.2	1390	106.72
Iron	63	896	27000	9825.49
Lead	58	4.3	1280	89.05
Magnesium	63	347	17900	3924.83
Manganese	63	20.5	5370	454.95
Mercury	47	0.0084	2.9	0.31
Molybdenum	38	0.9	97.3	11.11
Nickel	63	4.5	3590	161.54
Potassium	63	97.6	2580	697.20
Selenium	33	0.37	3.2	1.22
Silver	34	0.45	236	13.78
Sodium	15	102	1280	242.8
Thallium	33	0.43	61.8	18.33
Vanadium	63	2.9	92.2	22.23
Zinc	63	2.4	924	130.69
Volatile Organic Compounds (mg/kg)				
2-Butanone (MEK)	7	0.012	0.062	0.030
Acetone	51	0.0028	0.57	0.047
Acrylonitrile	1	0.014	0.014	0.014
Carbon disulfide	5	0.0017	0.01	0.0054
Chlorobenzene	18	0.0018	20	1.46
Dichlorodifluoromethane	2	0.0031	0.0043	0.0037
Ethyl methacrylate	1	0.0074	0.0074	0.0074
Ethylbenzene	4	0.0026	0.06	0.021
Methylene chloride	30	0.0012	0.009	0.003
Tetrachloroethene	1	0.0022	0.0022	0.0022
Toluene	3	0.0013	0.0025	0.0019
Trichlorofluoromethane	2	0.002	0.0035	0.00275
Xylenes (total)	5	0.0014	0.0094	0.00416

TABLE 5-6
MAXIMUM DETECTED CONCENTRATIONS AND ASSOCIATED SAMPLE LOCATION
FOR ANALYTES DETECTED IN SEDIMENT SAMPLES
FOURTH YEAR LONG-TERM MONITORING

COMPOUND NAME	SAMPLE_ID	RESULT	DETECTION LIMIT	% WATER	FOOTNOTES	DATE COLLECTED
PCBs & Pesticides (ug/kg)						
4,4'-DDD	QE04-SD-1201	5.7	4.2	22		07/22/98
4,4'-DDE	QE02-SD-1201	100	43	24		07/23/98
4,4'-DDT	QW07-SD-1201	14	4.4	25		07/20/98
Aldrin	QE02-SD-1201	110	22	24		07/23/98
Aroclor 1254	QE02-SD-1101	13000	2400	30.1		01/23/98
delta-BHC	QW04-SD-1101	2	2.2	22	JM	01/20/98
Endosulfan II	QE02-SD-1201	590	43	24		07/23/98
gamma-Chlordane	QE02-SD-1201	25	22	24		07/23/98
Semivolatile Organic Compounds (mg/kg)						
1,2-Dichlorobenzene	QE09-SD-1202	11	1.5	14		07/21/98
1,3-Dichlorobenzene	QE09-SD-1202	1.1	1.5	14	J	07/21/98
1,4-Dichlorobenzene	QE09-SD-1202	6.3	1.5	14		07/21/98
1-Chloronaphthalene	QE07-SD-1101	38	130	23.1	J	01/21/98
2,4-Dimethylphenol	QE09-SD-1101	0.062	0.47	30.3	J	01/21/98
2-Chloronaphthalene	QE08-SD-1202	0.71	0.42	22		07/21/98
2-Methylnaphthalene	QE08-SD-1202	1.6	0.42	22		07/21/98
2-Methylphenol	QE09-SD-1101	0.083	0.47	30.3	J	01/21/98
Acenaphthene	QE07-SD-1101	2.4	17	23.1	J	01/21/98
Acenaphthylene	QE02-SD-1201	0.09	0.43	24	J	07/23/98
Acetophenone	QW03-SD-1101	0.53	0.49	32.9		01/20/98
Anthracene	QE07-SD-1101	12	17	23.1	J	01/21/98
Azobenzene	QE09-SD-1101	0.053	0.47	30.3	J	01/21/98
Benzidine	QW03-SD-1101	0.11	4.9	32.9	J	01/20/98
Benzo(a)anthracene	QE07-SD-1101	46	17	23.1		01/21/98
Benzo(a)pyrene	QE07-SD-1101	63	17	23.1		01/21/98
Benzo(b)fluoranthene	QE07-SD-1101	55	17	23.1		01/21/98
Benzo(g,h,i)perylene	QE07-SD-1101	60	17	23.1		01/21/98
Benzo(k)fluoranthene	QE07-SD-1101	59	17	23.1		01/21/98
Benzoic acid	QW03-SD-1101	1.8	2.4	32.9	J	01/20/98
bis(2-Ethylhexyl)phthalate	QE02-SD-1101	16	1.9	30.1		01/23/98
Butyl benzyl phthalate	QW05-SD-1101	0.068	0.41	19.9	J	01/19/98
Chrysene	QE07-SD-1101	66	17	23.1		01/21/98
Di-n-butyl phthalate	QW02-SD-1101	0.47	0.46	27.6		01/20/98
Di-n-octyl phthalate	QE02-SD-1101	0.51	1.9	30.1	J	01/23/98
Dibenz(a,h)anthracene	QE07-SD-1101	15	17	23.1	J	01/21/98
Dibenz(a,j)acridine	QE07-SD-1102	0.94	17	21.6	J	01/21/98
Dibenzofuran	QE07-SD-1102	1.4	8.4	21.6	J	01/21/98
Fluoranthene	QE07-SD-1101	160	17	23.1		01/21/98
Fluorene	QE07-SD-1101	4.2	17	23.1	J	01/21/98
Indeno(1,2,3-cd)pyrene	QE07-SD-1101	49	17	23.1		01/21/98
Naphthalene	QE07-SD-1102	9.4	8.4	21.6		01/21/98
Naphthalene	QE07-SD-1101	9.4	17	23.1	J	01/21/98
Phenanthrene	QE07-SD-1101	70	17	23.1		01/21/98
Phenol	QW03-SD-1101	0.086	0.49	32.9	J	01/20/98
Pyrene	QE07-SD-1101	120	17	23.1		01/21/98
Total Metals (mg/kg)						
Aluminum	QW01-SD-1101	16300	12.7	21.4		01/20/98
Antimony	QE07-SD-1102	7.4	7.7	21.6	J	01/21/98

TABLE 5-6
MAXIMUM DETECTED CONCENTRATIONS AND ASSOCIATED SAMPLE LOCATION
FOR ANALYTES DETECTED IN SEDIMENT SAMPLES
FOURTH YEAR LONG-TERM MONITORING

COMPOUND NAME	SAMPLE_ID	RESULT	DETECTION LIMIT	% WATER	FOOTNOTES	DATE COLLECTED
Arsenic	QW05-SD-1201	12.2	6	16		07/20/98
Barium	QE11-SD-1101	4550	1.2	16		01/20/98
Beryllium	QW07-SD-1103	1.2	0.25	19.3		01/21/98
Cadmium	QE07-SD-1201	291	0.72	31		07/22/98
Calcium	QE07-SD-1103	184000	48.9	18.1		01/21/98
Chromium	QE07-SD-1102	1830	1.3	21.6		01/21/98
Cobalt	QW03-SD-1102	78.3	1.6	38.6		01/20/98
Copper	QE03-SD-1101	1390	2.8	29.7		01/23/98
Iron	QE02-SD-1101	27000	14.3	30.1	B	01/23/98
Lead	QE03-SD-1101	1280	7.1	29.7		01/23/98
Magnesium	QW06-SD-1201	17900	23.5	15		07/20/98
Manganese	QE02-SD-1101	5370	1.4	30.1		01/23/98
Mercury	QE09-SD-1202	2.9	0.38	14		07/21/98
Molybdenum	QW03-SD-1102	97.3	3.3	38.6		01/20/98
Nickel	QE02-SD-1101	3590	5.7	30.1		01/23/98
Potassium	QW01-SD-1101	2580	636	21.4		01/20/98
Selenium	QE03-SD-1101	3.2	0.71	29.7	q	01/23/98
Silver	QW03-SD-1102	236	1.6	38.6		01/20/98
Sodium	QW07-SD-1103	1280	620	19.3		01/21/98
Thallium	QE08-SD-1101	61.8	432	53.7	J	01/22/98
Vanadium	QE03-SD-1101	92.2	1.4	29.7		01/23/98
Zinc	QW03-SD-1102	924	3.3	38.6		01/20/98
Volatile Organic Compounds (mg/kg)						
2-Butanone (MEK)	QE08-SD-1101	0.062	0.022	53.7		01/22/98
Acetone	QE09-SD-1202	0.57	2.9	14	J B	07/21/98
Acrylonitrile	QE06-SD-1103	0.014	0.13	21.5	J	01/22/98
Carbon disulfide	QE02-SD-1101	0.01	0.036	30.1	J	01/23/98
Chlorobenzene	QE09-SD-1202	20	1.4	14		07/21/98
Dichlorodifluoromethane	QE08-SD-1101	0.0043	0.043	53.7	J	01/22/98
Ethyl methacrylate	QW03-SD-1102	0.0074	0.033	38.6	J	01/20/98
Ethylbenzene	QE07-SD-1102	0.06	0.0064	21.6		01/21/98
Methylene chloride	QE08-SD-1103	0.009	0.032	21.1	JB	01/22/98
Tetrachloroethene	QE08-SD-1101	0.0022	0.011	53.7	J	01/22/98
Toluene	QE08-SD-1101	0.0025	0.011	53.7	J	01/22/98
Trichlorofluoromethane	QE08-SD-1101	0.0035	0.011	53.7	J	01/22/98
Xylenes (total)	QE08-SD-1101	0.0094	0.011	53.7	J	01/22/98
Trichlorofluoromethane	QE08-SD-1101	0.0035	0.011	53.7	J	01/22/98
Xylenes (total)	QE08-SD-1101	0.0094	0.011	53.7	J	01/22/98

TABLE 5-7

EXCEEDANCES OF BASELINE HEALTH RISK ASSESSMENT 10^{-6} SCREENING CRITERIA

TO A DEPTH OF ONE FOOT

Sample Location	Sampling Interval (ft)	Analyte	10^{-6} Screening Criteria (ug/kg)	1Qtr1Yr Nov 1994 Detections (ug/kg)	2Qtr1Yr Jan 1995 Detections (ug/kg)	3Qtr1Yr April 1995 Detections (ug/kg)	4Qtr1Yr July 1995 Detections (ug/kg)	1Qtr2Yr Oct 1995 Detections (ug/kg)	2Qtr2Yr Mar 1996 Detections (ug/kg)	3Qtr2Yr May 1996 Detections (ug/kg)	4Qtr2Yr Aug 1996 Detections (ug/kg)	1Evnt3Yr Jan 1997 Detections (ug/kg)	2Evnt3Yr Jul 1997 Detections (ug/kg)	1Evnt4Yr Jan 1998 Detections (ug/kg)	2Evnt4Yr Jul 1998 Detections (ug/kg)
QE01	0-0.5	Benzo(a)anthracene	1,600	2,900	1,600	2,000	ND	2,800	640	710	3,300	1,900	430	300	ND
		Benzo(a)pyrene	1,600	2,200	1,100	2,200	ND	2,400	670	600	3,000	1,500	540	300	ND
		Benzo(b)fluoranthene	1,600	6,100	2,600	4,000	ND	5,700	1,500	1,000	5,600	1,200	460	250	ND
		Benzo(k)fluoranthene	1,600	ND	ND	ND	ND	ND	ND	410	ND	1,400	530	270	ND
		Chrysene	1,600	5,200	1,900	2,200	ND	2,300	980	860	4,100	2,000	680	350	ND
QE01	0.5-1.0	Benzo(a)anthracene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	10,000
		Benzo(a)pyrene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	7,200
		Benzo(b)fluoranthene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	7,300
		Benzo(k)fluoranthene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5,900
		Chrysene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	12,000
QE02	0-0.5	Benzo(a)anthracene	1,600	1,100	750	11,000	6,800	530	2,600	8,600	16,000	830	1,600	4,400	2,100
		Benzo(a)pyrene	1,600	930	720	9,800	6,300	420	3,000	7,300	14,000	870	1,600	4,400	2,100
		Benzo(b)fluoranthene	1,600	2,100	1,600	ND	6,300	1,700	4,900	12,000	27,000	990	1,700	3,600	2,000
		Benzo(k)fluoranthene	1,600	ND	ND	15,000	5,500	ND	ND	ND	ND	760	1,400	3,700	1,700
		Chrysene	1,600	1,100	860	14,000	7,200	800	3,300	8,600	18,000	1,100	2,200	5,000	2,500
QE02	0.5-1.0	Benzo(a)anthracene	1,600	NS	NS	13,000	NS	NS	NS	46,000	NS	1,600	NS	1,400	NS
		Benzo(a)pyrene	1,600	NS	NS	11,000	NS	NS	NS	35,000	NS	1,600	NS	1,300	NS
		Benzo(b)fluoranthene	1,600	NS	NS	20,000	NS	NS	NS	43,000	NS	1,800	NS	1,000	NS
		Benzo(k)fluoranthene	1,600	NS	NS	ND	NS	NS	NS	23,000	NS	1,100	NS	1,200	NS
		Chrysene	1,600	NS	NS	15,000	NS	NS	NS	42,000	NS	1,900	NS	1,700	NS
QE03	0-0.5	Benzo(a)anthracene	1,600	130	1,500	7,100	770	15,000	59,000	3,500	13,000	6,200	7,100	1,300	83
		Benzo(a)pyrene	1,600	210	1,300	5,600	750	12,000	45,000	3,000	11,000	7,000	5,900	1,300	120
		Benzo(b)fluoranthene	1,600	430	ND	11,000	1,400	21,000	83,000	5,900	14,000	8,300	6,600	2,000	120
		Benzo(k)fluoranthene	1,600	ND	2,800	ND	ND	ND	ND	ND	7,400	5,100	4,900	ND	92
		Chrysene	1,600	200	1,800	8,500	1,200	14,000	57,000	3,800	15,000	8,900	7,900	2,000	130
QE03	0.5-1.0	Benzo(a)anthracene	1,600	NS	NS	NS	3,200	NS	NS	6,800	6,300	NS	NS	NS	NS
		Benzo(a)pyrene	1,600	NS	NS	NS	2,800	NS	NS	5,600	6,200	NS	NS	NS	NS
		Benzo(b)fluoranthene	1,600	NS	NS	NS	3,400	NS	NS	11,000	9,300	NS	NS	NS	NS
		Benzo(k)fluoranthene	1,600	NS	NS	NS	2,600	NS	NS	ND	ND	NS	NS	NS	NS
		Chrysene	1,600	NS	NS	NS	3,900	NS	NS	6,600	7,200	NS	NS	NS	NS
QE04	0-0.5	Benzo(a)anthracene	1,600	42	NS	70	39,000	240	ND	ND	ND	520	ND	150	ND
		Benzo(a)pyrene	1,600	ND	NS	61	26,000	230	ND	ND	ND	470	ND	170	ND
		Benzo(b)fluoranthene	1,600	140	NS	150	ND	520	ND	ND	ND	490	ND	160	ND
		Benzo(k)fluoranthene	1,600	ND	NS	ND	39,000	ND	ND	ND	ND	470	ND	180	ND
		Chrysene	1,600	93	NS	130	35,000	300	ND	ND	ND	730	ND	180	ND
QE05	0-0.5	Benzo(a)anthracene	1,600	81	680	710	3,600	1,600	1,100	180	530	130	1,200	ND	1,100
		Benzo(a)pyrene	1,600	84	690	640	3,200	1,300	910	170	590	150	940	ND	960
		Benzo(b)fluoranthene	1,600	180	1,600	1,400	3,100	2,200	1,700	360	1,200	180	1,000	ND	880
		Benzo(k)fluoranthene	1,600	ND	ND	ND	3,400	ND	ND	ND	ND	150	1,300	ND	940
		Chrysene	1,600	130	870	980	4,400	1,800	1,200	240	810	230	1,300	ND	1,400
QE05	0.5-1.0	Benzo(a)anthracene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1,400
		Benzo(a)pyrene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1,300
		Benzo(b)fluoranthene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1,500
		Benzo(k)fluoranthene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1,300
		Chrysene	1,600	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1,600

TABLE 5-7
EXCEEDANCES OF BASELINE HEALTH RISK ASSESSMENT 10^{-6} SCREENING CRITERIA
TO A DEPTH OF ONE FOOT

Sample Location	Sampling Interval (ft)	Analyte	10^{-6} Screening Criteria (ug/kg)	1Qtr1Yr Nov 1994 Detections (ug/kg)	2Qtr1Yr Jan 1995 Detections (ug/kg)	3Qtr1Yr April 1995 Detections (ug/kg)	4Qtr1Yr July 1995 Detections (ug/kg)	1Qtr2Yr Oct 1995 Detections (ug/kg)	2Qtr2Yr Mar 1996 Detections (ug/kg)	3Qtr2Yr May 1996 Detections (ug/kg)	4Qtr2Yr Aug 1996 Detections (ug/kg)	1Evnt3Yr Jan 1997 Detections (ug/kg)	2Evnt3Yr Jul 1997 Detections (ug/kg)	1Evnt4Yr Jan 1998 Detections (ug/kg)	2Evnt4Yr Jul 1998 Detections (ug/kg)
QE06	0-0.5	Benzo(a)anthracene	1,600	1,100	130	8,100	8,200	1,700	2,200	2,200	3,900	5,400	1,500	2,600	2,600
		Benzo(a)pyrene	1,600	920	100	7,400	8,800	1,500	1,900	2,100	3,300	6,800	1,400	3,000	2,500
		Benzo(b)fluoranthene	1,600	2,000	300	10,000	9,800	2,800	3,700	4,200	6,900	8,800	2,100	2,300	2,800
		Benzo(k)fluoranthene	1,600	ND	ND	4,700	9,300	ND	ND	ND	ND	7,000	2,000	2,800	2,100
		Chrysene	1,600	1,200	200	9,300	11,000	1,900	2,700	2,600	5,300	9,300	2,200	3,700	3,500
QE06	0.5-1.0	Benzo(a)anthracene	1,600	15,000	1,300	4,900	830	1,300	1,300	1,100	1,600	2,900	1,300	5,000	2,100
		Benzo(a)pyrene	1,600	14,000	1,200	6,000	1,200	1,100	1,500	1,000	1,500	ND	1,500	5,700	2,400
		Benzo(b)fluoranthene	1,600	28,000	2,100	11,000	1,800	ND	2,600	2,000	3,300	2,900	2,300	4,500	2,500
		Benzo(k)fluoranthene	1,600	ND	ND	ND	ND	2,100	ND	ND	ND	2,800	1,800	4,300	2,200
		Chrysene	1,600	19,000	1,300	6,600	1,300	1,400	1,800	1,300	2,200	4,000	2,300	4,700	3,000
QE07	0-0.5	Benzo(a)anthracene	1,600	1,100	2,000	2,300	720	26,000	2,100	1,000	880	9,100	540	46,000	2,300
		Benzo(a)pyrene	1,600	830	2,200	2,200	670	26,000	2,100	1,000	720	11,000	540	63,000	2,300
		Benzo(b)fluoranthene	1,600	1,600	3,900	3,800	1,300	49,000	4,000	2,000	1,400	13,000	610	55,000	2,100
		Benzo(k)fluoranthene	1,600	ND	ND	ND	ND	ND	ND	ND	ND	8,600	490	59,000	2,100
		Chrysene	1,600	1,200	2,000	2,200	1,000	33,000	2,700	1,400	1,000	12,000	760	66,000	2,900
QE07	0.5-1.0	Benzo(a)anthracene	1,600	1,600	3,000	4,000	NS	21,000	6,200	1,300	NS	4,700	1,700	34,000	540
		Benzo(a)pyrene	1,600	1,400	2,700	2,600	NS	19,000	4,700	1,400	NS	5,000	1,900	39,000	660
		Benzo(b)fluoranthene	1,600	2,600	4,900	4,500	NS	33,000	8,300	2,800	NS	5,900	1,500	40,000	770
		Benzo(k)fluoranthene	1,600	ND	ND	ND	NS	ND	ND	ND	NS	4,800	2,000	33,000	590
		Chrysene	1,600	1,800	3,300	3,300	NS	21,000	5,900	1,800	NS	6,300	2,100	47,000	830
QE08	0-0.5	Benzo(a)anthracene	1,600	2,200	2,100	11,000	1,900	3,100	4,600	11,000	1,000	7,300	6,900	3,200	8,000
		Benzo(a)pyrene	1,600	2,200	1,800	7,700	1,700	3,000	5,000	10,000	1,000	7,300	9,300	4,100	9,300
		Benzo(b)fluoranthene	1,600	4,400	4,000	19,000	3,300	6,500	9,600	20,000	2,000	9,600	11,000	3,900	13,000
		Benzo(k)fluoranthene	1,600	ND	ND	ND	ND	ND	ND	ND	ND	5,900	12,000	3,200	8,300
		Chrysene	1,600	2,800	2,600	15,000	2,700	4,300	5,700	12,000	1,500	9,200	12,000	5,000	12,000
QE08	0.5-1.0	Benzo(a)anthracene	1,600	1,300	270	ND	990	1,900	380	1,300	5,600	290	330	870	1,100
		Benzo(a)pyrene	1,600	1,700	240	ND	ND	1,800	370	1,100	4,100	310	310	1,100	1,100
		Benzo(b)fluoranthene	1,600	3,500	520	350	1,600	2,400	600	2,200	7,300	340	370	930	1,300
		Benzo(k)fluoranthene	1,600	ND	ND	ND	ND	1	250	ND	ND	280	300	1,100	790
		Chrysene	1,600	2,100	350	280	1,600	2,800	500	1,800	6,500	440	630	1,400	1,300
QE09	0-0.5	Benzo(a)anthracene	1,600	250	ND	870	530	80	390	90	ND	97	1,000	1,500	100
		Benzo(a)pyrene	1,600	260	ND	890	550	87	340	83	ND	130	1,300	2,000	94
		Benzo(b)fluoranthene	1,600	460	ND	1,500	1,000	160	740	140	ND	110	1,400	1,900	93
		Benzo(k)fluoranthene	1,600	ND	ND	ND	ND	ND	ND	ND	ND	130	1,400	1,800	93
	0-0.5	Chrysene	1,600	380	ND	1,100	780	150	530	120	ND	160	1,700	2,300	100
QE10	0-0.5	Benzo(a)anthracene	1,600	ND	NS	ND	1,500	45	NS	ND	ND	ND	ND	ND	ND
		Benzo(a)pyrene	1,600	ND	NS	ND	1,300	47	NS	ND	ND	ND	ND	ND	ND
		Benzo(b)fluoranthene	1,600	ND	NS	ND	2,300	94	NS	ND	ND	ND	ND	ND	ND
		Benzo(k)fluoranthene	1,600	ND	NS	ND	ND	ND	NS	ND	ND	ND	ND	ND	ND
		Chrysene	1,600	ND	NS	ND	2,100	86	NS	ND	ND	ND	ND	ND	ND
QW02	0-0.5	Benzo(a)anthracene	1,600	560	600	360	1,900	2,200	72	870	740	1,300	ND	210	NS
		Benzo(a)pyrene	1,600	660	700	430	1,400	1,900	91	960	1,000	1,700	55	290	NS
		Benzo(b)fluoranthene	1,600	760	1,400	810	2,700	ND	180	1,900	1,400	1,900	52	230	NS
		Benzo(k)fluoranthene	1,600	690	ND	ND	ND	ND	ND	ND	910	2,400	53	270	NS
		Chrysene	1,600	850	730	520	2,200	2,700	96	1,000	1,200	1,700	68	310	NS

TABLE 5-7

EXCEEDANCES OF BASELINE HEALTH RISK ASSESSMENT 10^{-6} SCREENING CRITERIA
TO A DEPTH OF ONE FOOT

Sample Location	Sampling Interval (ft)	Analyte	10^{-6} Screening Criteria (ug/kg)	1Qtr1Yr Nov 1994 Detections (ug/kg)	2Qtr1Yr Jan 1995 Detections (ug/kg)	3Qtr1Yr April 1995 Detections (ug/kg)	4Qtr1Yr July 1995 Detections (ug/kg)	1Qtr2Yr Oct 1995 Detections (ug/kg)	2Qtr2Yr Mar 1996 Detections (ug/kg)	3Qtr2Yr May 1996 Detections (ug/kg)	4Qtr2Yr Aug 1996 Detections (ug/kg)	1Evnt3Yr Jan 1997 Detections (ug/kg)	2Evnt3Yr Jul 1997 Detections (ug/kg)	1Evnt4Yr Jan 1998 Detections (ug/kg)	2Evnt4Yr Jul 1998 Detections (ug/kg)
QW02	0.5-1.0	Benzo(a)anthracene	1,600	120	250	360	2,400	ND	ND	97	NS	ND	ND	NS	NS
		Benzo(a)pyrene	1,600	130	300	440	3,100	46	ND	96	NS	ND	ND	NS	NS
		Benzo(b)fluoranthene	1,600	130	580	790	4,600	ND	77	180	NS	ND	ND	NS	NS
		Benzo(k)fluoranthene	1,600	130	ND	ND	2,200	ND	ND	ND	NS	ND	ND	NS	NS
		Chrysene	1,600	160	330	440	3,900	ND	ND	110	NS	ND	ND	NS	NS
QW03	0-0.5	Benzo(a)anthracene	1,600	110	980	ND	440	1,600	610	530	480	260	330	320	NS
		Benzo(a)pyrene	1,600	ND	1,600	1,100	470	2,100	880	660	780	350	450	390	NS
		Benzo(b)fluoranthene	1,600	160	3,000	2,000	860	3,700	1,900	1,300	820	320	620	330	NS
		Benzo(k)fluoranthene	1,600	ND	ND	ND	ND	ND	ND	ND	850	570	390	380	NS
		Chrysene	1,600	190	1,700	1,100	510	2,500	910	740	720	390	470	420	NS
QW03	0.5-1.0	Benzo(a)anthracene	1,600	NS	44	43	360	ND	700	230	230	1,600	86	240	NS
		Benzo(a)pyrene	1,600	NS	66	ND	340	ND	930	310	370	1,800	95	400	NS
		Benzo(b)fluoranthene	1,600	NS	ND	ND	65	180	1,700	650	440	2,200	120	ND	NS
		Benzo(k)fluoranthene	1,600	NS	110	81	ND	ND	ND	ND	320	2,300	100	750	NS
		Chrysene	1,600	NS	67	42	400	ND	1,100	340	340	2,100	130	420	NS
QW04	0-0.5	Benzo(a)anthracene	1,600	2,700	730	1,000	260	520	130	3,400	1,900	1,900	110	ND	NS
		Benzo(a)pyrene	1,600	2,600	1,100	1,300	300	480	200	3,600	2,200	5,200	120	ND	NS
		Benzo(b)fluoranthene	1,600	2,600	2,100	ND	650	790	350	7,000	2,600	4,200	110	ND	NS
		Benzo(k)fluoranthene	1,600	2,400	ND	2,400	ND	ND	ND	ND	2,100	4,100	120	ND	NS
		Chrysene	1,600	3,000	1,200	1,200	390	630	190	4,100	2,700	2,500	150	ND	NS
QW04	05.-1.0	Benzo(a)anthracene	1,600	1,100	2,500	1,200	2,400	350	120	1,100	89	4,700	97	ND	NS
		Benzo(a)pyrene	1,600	1,500	3,100	1,300	3,200	380	210	1,000	98	4,600	120	ND	NS
		Benzo(b)fluoranthene	1,600	2,200	6,000	2,200	6,600	ND	390	1,800	120	5,600	120	ND	NS
		Benzo(k)fluoranthene	1,600	ND	ND	ND	ND	800	ND	ND	93	5,500	140	ND	NS
		Chrysene	1,600	1,500	3,100	1,100	5,000	450	190	1,200	120	6,100	170	ND	NS
QW05	0-0.5	Benzo(a)anthracene	1,600	360	ND	3,500	ND	ND	ND	ND	ND	9,900	ND	570	89
		Benzo(a)pyrene	1,600	430	ND	2,100	ND	ND	ND	ND	ND	7,900	ND	580	88
		Benzo(b)fluoranthene	1,600	920	48	ND	65	40	50	67	ND	9,400	ND	400	65
		Benzo(k)fluoranthene	1,600	ND	ND	5,300	ND	ND	ND	ND	ND	8,300	ND	580	90
		Chrysene	1,600	1,100	ND	3,700	51	ND	ND	ND	ND	12,000	ND	680	86

Notes:

NS - No sample obtained during the monitoring event

ND - Non-detect

Shading indicates exceedance of the BHRA 10-6 screening criteria:

TABLE 5-8

EXCEEDANCES OF HUMAN HEALTH RISK ASSESSMENT 10^{-5} SCREENING CRITERIA

Sample Location	Sampling Interval (ft)	Analyte	10^{-5} Screening Criteria (ug/kg)	1Qtr1Yr Nov 1994 Detections (ug/kg)	2Qtr1Yr Jan 1995 Detections (ug/kg)	3Qtr1Yr April 1995 Detections (ug/kg)	4Qtr1Yr July 1995 Detections (ug/kg)	1Qtr2Yr Oct 1995 Detections (ug/kg)	2Qtr2Yr Mar 1996 Detections (ug/kg)	3Qtr2Yr May 1996 Detections (ug/kg)	4Qtr2Yr Aug 1996 Detections (ug/kg)	1Evnt3Yr Jan 1997 Detections (ug/kg)	2Evnt3Yr Jul 1997 Detections (ug/kg)	1Evnt4Yr Jan 1998 Detections (ug/kg)	2Evnt4Yr Jul 1998 Detections (ug/kg)
QE02	0.5-1.0	Benzo(a)pyrene	10,575	NS	NS	11000	NS	NS	NS	35000	NS	1600	NS	1300	NS
QE03	0-0.5	Benzo(a)pyrene	10,575	NS	NS	11000	NS	12000	45000	3000	11000	7000	5900	1300	120
QE04	0-0.5	Benzo(a)pyrene	10,575	ND	NS	61	26000	230	ND	ND	ND	470	ND	170	ND
QE06	0.5-1.0	Benzo(a)pyrene	10,575	14000	1200	6000	1200	1100	1500	1000	1500	ND	1500	5700	2400
QE07	0-0.5	Heptachlor	17,156	120	1200	ND	52000	7000	630	320	ND	ND	ND	ND	ND
		Benzo(a)-pyrene	10,575	830	2200	2200	670	26000	2100	1000	720	11000	540	63000	2300
		Dibenz(a,h)anthracene	10,575	54	ND	260	130	ND	330	130	73	1900	150	15000	280
QE07	0.5-1.0	Benzo(a)-pyrene	10,575	1400	2700	2600	NS	19000	4700	1400	NS	5000	1900	39000	660
		Dibenz(a,h)anthracene	10,575	160	ND	1000	NS	2100	570	190	NS	900	360	11000	160

Notes:

NS - No sample obtained during the monitoring event

ND - Non-detect

Shading indicates exceedance of the HHRA 10^{-5} screening criteria

TABLE 5-9

EXCEEDANCES OF HUMAN HEALTH RISK ASSESSMENT 10^{-6} SCREENING CRITERIA

Sample Location	Sampling Interval (ft)	Analyte	10^{-6} Screening Criteria (ug/kg)	1Qtr1Yr Nov 1994 Detections (ug/kg)	2Qtr1Yr Jan 1995 Detections (ug/kg)	3Qtr1Yr April 1995 Detections (ug/kg)	4Qtr1Yr July 1995 Detections (ug/kg)	1Qtr2Yr Oct 1995 Detections (ug/kg)	2Qtr2Yr Mar 1996 Detections (ug/kg)	3Qtr2Yr May 1996 Detections (ug/kg)	4Qtr2Yr Aug 1996 Detections (ug/kg)	1Evnt3Yr Jan 1997 Detections (ug/kg)	2Evnt3Yr Jul 1997 Detections (ug/kg)	1Evnt4Yr Jan 1998 Detections (ug/kg)	2Evnt4Yr Jul 1998 Detections (ug/kg)
QE01	0-0.5	Benzo(a)pyrene	1,057	2200	1100	2200	ND	2,400	670	600	3,000	1,500	540	300	ND
QE01	0.5-1.0	Benzo(a)pyrene	1,057	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	7,200
QE02	0-0.5	Benzo(a)anthracene	10,575	1100	750	11000	6800	530	2,600	8,600	16,000	830	1,600	4,400	2,100
		Benzo(a)pyrene	1,057	930	720	9800	6300	420	3,000	7,300	14,000	870	1,600	4,400	2,100
		Benzo(b)fluoranthene	10,575	2100	1600	ND	6300	1,700	4,900	12,000	27,000	990	1,700	3,600	200
		Dibenz(a,h)anthracene	1,057	ND	ND	1500	1600	ND	420	970	ND	ND	ND	1,600	600
		Aldrin	454	ND	ND	ND	1600	810	ND	ND	ND	ND	ND	ND	110
QE02	0.5-1.0	Benzo(a)anthracene	10,575	NS	NS	13000	NS	NS	NS	46,000	NS	1,600	NS	1,400	NS
		Benzo(a)pyrene	1,057	NS	NS	11000	NS	NS	NS	35,000	NS	1,600	NS	1,300	NS
		Benzo(b)fluoranthene	10,575	NS	NS	20000	NS	NS	NS	43,000	NS	1,800	NS	1,000	NS
		Dibenz(a,h)anthracene	1,057	NS	NS	1300	NS	NS	NS	4,100	NS	270	NS	360	NS
		Indeno(1,2,3-cd)pyrene	10,575	NS	NS	5600	NS	NS	NS	15,000	NS	790	NS	1,100	NS
QE03	0-0.5	Benzo(a)anthracene	10,575	130	1500	7100	770	15,000	59,000	3,500	13,000	6,200	7,100	1,300	83
		Benzo(a)pyrene	1,057	210	1300	5600	750	12,000	45,000	3,000	11,000	7,000	5,900	1,300	120
		Benzo(b)fluoranthene	10,575	430	ND	11000	1400	21,000	83,000	5,900	14,000	8,300	6,600	2,000	120
		Dibenz(a,h)anthracene	1,057	ND	ND	690	ND	1,300	6,000	460	ND	1,300	ND	360	ND
		Indeno(1,2,3-cd)pyrene	10,575	ND	ND	2600	470	5,100	20,000	1,700	6,100	4,000	2,300	940	99
QE03	0.5-1.0	Benzo(a)pyrene	1,057	NS	NS	NS	2800	NS	NS	5,600	6,200	NS	NS	NS	NS
		Benzo(b)fluoranthene	10,575	NS	NS	NS	3400	NS	NS	11,000	9,300	NS	NS	NS	NS
QE04	0-0.5	Benzo(a)pyrene	1,057	ND	NS	61	26000	230	ND	ND	ND	470	ND	170	ND
		Benzo(a)anthracene	10,575	42	NS	70	39000	240	ND	ND	ND	520	ND	150	ND
		Dibenz(a,h)anthracene	1,057	ND	NS	ND	10000	ND	ND	ND	ND	120	ND	ND	ND
		Indeno(1,2,3-cd)pyrene	10,575	ND	NS	ND	19000	89	ND	ND	ND	300	ND	120	ND
QE05	0-0.5	Benzo(a)pyrene	1,057	84	690	640	3200	1,300	910	170	590	150	940	ND	1,300
QE06	0-0.5	Benzo(a)pyrene	1,057	920	100	7400	8800	1,500	1,900	2,100	3,300	6,800	1,400	3,000	2,500
		Dibenz(a,h)anthracene	1,057	ND	ND	1100	2200	170	350	290	ND	1,500	ND	790	380
QE06	0.5-1.0	Benzo(a)anthracene	10,575	15000	1300	4900	830	1,300	1,300	1,100	1,600	2,900	1,300	5,000	2,100
		Benzo(a)pyrene	1,057	14000	1200	6000	1200	1,100	1,500	1,000	1,500	ND	1,500	5,700	2,400
		Benzo(b)fluoranthene	10,575	28000	2100	11000	1800	ND	2,600	2,000	3,300	2,900	2,300	4,500	2,500
		Dibenz(a,h)anthracene	1,057	ND	ND	670	ND	ND	ND	ND	ND	360	330	1,500	620
QE06	> 1	Benzo(a)pyrene	1,057	3100	850	NS	920	NS	1,800	560	830	1,600	NS	790	NS
QE07	0-0.5	Aldrin	454	57	ND	840	ND	3,700	ND	ND	ND	ND	ND	ND	ND
		alpha-Chlordane	5,939	ND	ND	ND	ND	16,000	480	ND	ND	ND	ND	ND	ND
		Benzo(a)anthracene	10,575	1100	2000	2300	720	26,000	2,100	1,000	880	9,100	540	46,000	2,300
		Benzo(a)pyrene	1,057	830	2200	2200	670	26,000	2,100	1,000	720	11,000	540	63,000	2,300
		Benzo(b)fluoranthene	10,575	1600	3900	3800	1300	49,000	4,000	2,000	1,400	13,000	610	55,000	2,100
		Dibenz(a,h)anthracene	1,057	54	ND	260	130	ND	330	130	73	1,900	150	15,000	280
		Heptachlor	1,715	120	1200	ND	52000	7,000	600	310	ND	ND	ND	ND	ND

TABLE 5-9

EXCEEDANCES OF HUMAN HEALTH RISK ASSESSMENT 10^{-6} SCREENING CRITERIA

Sample Location	Sampling Interval (ft)	Analyte	10^{-6} Screening Criteria (ug/kg)	1Qtr1Yr Nov 1994 Detections (ug/kg)	2Qtr1Yr Jan 1995 Detections (ug/kg)	3Qtr1Yr April 1995 Detections (ug/kg)	4Qtr1Yr July 1995 Detections (ug/kg)	1Qtr2Yr Oct 1995 Detections (ug/kg)	2Qtr2Yr Mar 1996 Detections (ug/kg)	3Qtr2Yr May 1996 Detections (ug/kg)	4Qtr2Yr Aug 1996 Detections (ug/kg)	1Evnt3Yr Jan 1997 Detections (ug/kg)	2Evnt3Yr Jul 1997 Detections (ug/kg)	1Evnt4Yr Jan 1998 Detections (ug/kg)	2Evnt4Yr Jul 1998 Detections (ug/kg)
		Indeno(1,2,3-cd)pyrene	10,575	440	1000	1200	420	14,000	1,100	510	250	4,600	340	49,000	1,600
QE07	0.5-1.0	Aldrin	454	ND	ND	650	NS	2,500	ND	ND	NS	ND	ND	ND	ND
		alpha-Chlordane	5,939	ND	ND	ND	NS	15,000	250	98	NS	ND	ND	ND	ND
		Benzo(a)anthracene	10,575	1600	3000	4000	NS	21,000	6,200	1,300	NS	4,700	1,700	34,000	540
		Benzo(a)pyrene	1,057	1400	2700	2600	NS	19,000	4,700	1,400	NS	5,000	1,900	39,000	660
		Benzo(b)fluoranthene	10,575	2600	4900	4500	NS	33,000	8,300	2,800	NS	5,900	1,500	40,000	770
		Dibenz(a,h)anthracene	1,057	160	ND	140	NS	2,100	570	190	NS	900	360	11,000	160
		Indeno(1,2,3-cd)pyrene	10,575	800	1500	1000	NS	8,200	1,900	730	NS	1,900	1,000	31,000	540
		Heptachlor	1,715	820	1400	ND	NS	4,600	390	140	NS	ND	ND	ND	ND
QE07	> 1	Benzo(a)pyrene	1,057	2600	NS	270	NS	1,200	NS	ND	NS	54	ND	5,000	60
QE08	0-0.5	Benzo(a)anthracene	10,575	2200	2100	11000	1900	3,100	4,600	11,000	1,000	7,300	6,900	3,200	8,000
		Benzo(a)pyrene	1,057	2200	1800	7700	1700	3,000	5,000	10,000	1,000	7,300	9,300	4,100	9,300
		Benzo(b)fluoranthene	10,575	4400	4000	19000	3300	6,500	9,600	20,000	2,000	9,600	11,000	3,900	13,000
		Dibenz(a,h)anthracene	1,057	54	ND	1600	ND	ND	770	1,100	ND	1,600	1,500	1,200	2,700
QE08	0.5-1.0	Benzo(a)pyrene	1,057	1700	240	ND	ND	1,800	370	1,100	4,100	310	310	1,100	1,100
QE09	0-0.5	Benzo(a)pyrene	1,057	830	ND	890	550	87	340	83	ND	130	1,300	2,000	94
QE09	> 1	Heptachlor	1,715	ND	36	ND	3100	8	21	ND	ND	ND	NS	ND	NS
QE10	0-0.5	Benzo(a)pyrene	1,057	ND	NS	ND	1300	47	NS	ND	ND	ND	ND	ND	ND
QW02	0-0.5	Benzo(a)pyrene	1,057	660	700	430	1400	1,900	91	960	1,000	1,700	55	290	NS
QW02	0.5-1.0	Benzo(a)pyrene	1,057	130	300	440	3100	46	ND	96	NS	ND	ND	NS	NS
QW03	0-0.5	Benzo(a)pyrene	1,057	ND	1600	1100	470	2,100	880	660	780	350	450	390	NS
QW03	0.5-1.0	Benzidine	420	NS	430	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS
QW04	0-0.5	Benzo(a)pyrene	1,057	2600	1100	1300	300	480	200	3,600	2,200	5,200	120	ND	NS
		Dibenz(a,h)anthracene	1,057	750	150	220	ND	60	ND	590	770	1,600	ND	ND	NS
QW04	0.5-1.0	Benzo(a)pyrene	1,057	1500	3100	1300	3200	380	210	1,000	98	4,600	120	ND	NS
QW04	> 1	Benzo(a)pyrene	1,057	580	NS	3100	3200	1,900	370	330	53	5,800	84	NS	NS
QW05	0-0.5	Benzo(a)pyrene	1,057	430	ND	2100	ND	ND	ND	ND	ND	7,900	ND	580	88

Notes:

NS - No sample obtained during the monitoring event

ND - Non-detect

Shading indicates exceedance of the HHRA 10^{-6} screening criteria

TABLE 5-10
COMPARISON OF LONG-TERM MONITORING MAXIMUM ANALYTE CONCENTRATIONS WITH RI RESULTS IN SEDIMENT

Analytes	Phase I RI	Phase II RI	1qtr1yr (Nov 1994)		2qtr1yr (Jan 1995)		3qtr1yr (Apr 1995)		4qtr1yr (Jul 1995)		1qtr2yr (Oct 95)		2qtr2yr (Mar 96)		3qtr2yr (May 96)		4qtr2yr (Aug 96)		1Evnt3Yr (Jul 97)		2Evnt3Yr (Jan 97)		1Evnt4Yr (Jul 98)		2Evnt4Yr (Jan 9	
			0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in
Metals (mg/kg)																														
Aluminum	42300		14100	16400	23400	20000	21000	16400	13400	12900	21000	21200	17000	9490	16700	15400	23400	13500	22700	13800	12000	8940	16300	10500	11900	8690
Antimony					9.8	6.2	7.9	9.5	8.6		15.8	5.6			7.9		17.3				7.6	6.2	2.9	7.4	7.2	4.1
Arsenic	15.7		7.5	7.5	7.2	5.3	8.4	7.2	9	5.7	5.2	8.7	10.5	3.2	6.4	6.1	13.2	7.3	15.7	7.2	5.3	4.8	9.7	3.6	12.2	4.4
Barium	2910		3850	1010	2380	1350	1860	12000	1690	1050	3350	807	2440	620	1330	1270	1840	2010	3200	1790	2370	655	4550	599	890	914
Beryllium			1.1	1.3	1.2	1.2	1.5	1.2	0.85	0.82	1.2	1.4	1.2	0.72	1	0.78	1.5	0.97	1.7	0.81	0.97	0.93	1	0.93	0.97	0.73
Boron																										
Cadmium	428	15.7	123	328	83.2	132	106	183	415	108	87.3	306	85.1	120	390	158	242	29.8	80	112	837	255	127	193	291	115
Calcium	72500		181000	132000	128000	36000	142000	81200	210000	174000	214000	107000	231000	54700	140000	94300	79200	76800	141000	121000	79300	67800	102000	70200	96700	59200
Chromium	2020	186	820	13350	1230	2430	1890	828	2040	3210	912	5140	2920	977	2230	1460	1870	1850	2800	1110	1700	1210	994	1830	732	734
Cobalt	52.1		42.1	35.7	123	91.8	61.7	56.7	21.6	126	108	105	51.8	80.4	109	20.1	90.1	15.1	61.7	166	36.6	16.4	331.1	78.3	23.9	10.1
Copper	600		541	168	650	125	583	246	2210	175	654	1220	551	181	467	217	17000	292	581	2010	548	401	1390	498	514	94.5
Iron	41200		19000	26600	249000	19800	21100	21800	24900	22200	24900	27900	26700	15500	20200	17800	27500	31800	24400	18500	15300	20300	27000	14100	18500	14700
Lead	586	152	318	184	225	469	268	286	4400	746	498	616	291	187	1050	170	1210	224	528	422	415	160	1280	306	158	188
Magnesium	20400		22800	15200	16700	12000	13600	10300	306000	17000	24100	13100	12400	9590	17300	15000	6120	9150	27100	22000	23900	7320	14900	10500	17900	10500
Manganese	1490		890	965	836	1750	778	2030	1930	4250	1730	1130	857	653	4140	853	1840	2940	1780	1890	1830	725	5370	887	1390	898
Mercury	2.6		0.55	0.3	.9	.3	.59	.81	0.63	0.58	1.5	1.1	4.7	0.5	0.9	0.67	3.8	0.67	3.7	0.55	8.3	0.41	1.2	0.69	1.1	2.9
Molybdenum			23.8	26	62.6	34.8	36.9	56.4	25.5	17.9	39.4	136	135	28	32.6	21	62.1	27.7	41.8	262	14.5	7.7	62.8	97.3	14.6	14.6
Nickel	2270		704	1090	3160	1370	2830	1220	747	861	3690	8790	3600	1790	778	431	1420	801	1430	6470	180	480	3590	3010	300	184
Potassium	2300		2030	2910	4230	4880	3200	2850	1930	1590	2830	2820	2780	1380	2530	2450	3010	2400	2730	2050	1430	1400	2580	1550	1720	1280
Selenium	10.2		3.4	4.2	12	2	4.3	.79	1	0.85	7.2	17.7	6.2	1.3	0.93	0.54	7.2	5.5	7.5	10.3	2.1	1.9	3.2	2.6	3.1	1.6
Silver	112		64.6	79.4	205	72.2	91.9	6.9	18.7	15.9	112	245	131	80	102	19.1	42.7	2.3	99.2	725	15.2	14.8	45.3	236	16.3	12
Sodium			1890	819					191	165	400	392			270	296					242	517	244	170	181	194
…um			0.38	0.19			.2		0.14	0.18	0.33	0.2(			62.6	51.4	61.6	52.5	127	126	37.8	36.5	61.8	40.9	8.6	1.3
Tin																										
Vanadium	52.9		48.7	58.7	95.7	42.1	67.9	38.4	48.3	47	75.4	112	121	48.7	46.3	31.7	57	56.8	82.9	117	45.8	36	92.2	51.7	47.6	31.8
Zinc	640		668	372	1790	506	1280	311	890	542	1920	2570	1670	557	442	209	759	227	1180	2310	671	268	647	924	489	264
PCB's and Chlorinated Pesticides (mg/kg)																										
4,4'-DDD											260		890		72	63					0.042	0.037			0.0057	
4,4'-DDE																					0.0085				0.10	
4,4'-DDT																									0.014	
Aldrin			57	120		1.4	840	650			3700	2500							0.0067		0.097				0.11	
alpha-BHC							2																			
alpha-Chlordane				910							16000	15000	480	250	120	98					0.013					
Aroclor 1016																										
Aroclor 1221																										
Aroclor 1232																										
Aroclor 1242																										
Aroclor 1248																										
Aroclor 1254			8300	5200	24000	33000	40000	18000	25000	17000	39000	19000	15000	86000	20000	51000	61000	8200	10	82	3.6	0.24	13	9	4.7	0.38
Aroclor 1260																	480				0.68					
beta-BHC																										
delta-BHC			140	370							3200												0.002			
Dieldrin											25000	18000	890		890	280					0.0021					
Endosulfan I																										
Endosulfan II																					0.093	0.079			0.59	
Endosulfan sulfate							41																			
Endrin			2																							
gamma-BHC (Lindane)																										
…a-Chlordane												38								0.02	0.023				0.025	
…achlor			180	820	1200	1400		110	52000	49	7000	4600	600	390	310	190										

TABLE 5-10
COMPARISON OF LONG-TERM MONITORING MAXIMUM ANALYTE CONCENTRATIONS WITH RI RESULTS IN SEDIMENT

Analytes	Phase I RI	Phase II RI	1qtr1yr (Nov 1994)		2qtr1yr (Jan 1995)		3qtr1yr (Apr 1995)		4qtr1yr (Jul 1995)		1qtr2yr (Oct 95)		2qtr2yr (Mar 96)		3qtr2yr (May 96)		4qtr2yr (Aug 96)		1Evnt3Yr (Jul 97)		2Evnt3Yr (Jan 97)		1Evnt4Yr (Jul 98)		2Evnt4Yr (Jan 98	
			0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in
Heptachlor epoxide						210															0.0028					
Methoxychlor			19																							
Toxaphene																										
Volatile Organics (mg/kg)																										
1,1,1,2-Tetrachloroethane			2.6																							
1,1,1-Trichloroethane												29			2.6											
1,1,2,2-Tetrachloroethane																			0.0027							
1,1,2-Trichloroethane																										
1,1-Dichloroethane												2.5			1.7						0.0016					
1,1-Dichloroethene																										
1,2,3-Trichloropropane			1.7																							
1,2-Dichloroethane							2.1	6.8																		
1,2-Dichloropropane																										
2-Butanone (MEK)			6.9	12	21	26	2900	51	80	15	62	99	25	7.9	250	19	56	71	0.047	0.037	0.048	0.018	0.062	0.016	0.059	0.012
2-Chlorethyl vinyl ether																										
2-Hexanone					14																					
4-Methyl-2-pentanone (MIBK)					5																					
Acetone	1700	51	100	62	100	130	950	240	490	82	120	54	200	70	740	62	190	79	0.026	0.19	0.23	0.097	0.21	0.063	0.13	0.57
Acrolein										10																
Acrylonitrile			4.5																0.0015							
Benzene		1		2.2		1.5	1.7	5.6													0.021					
Bromodichloromethane																										
[illegible]oform																										
B[illegible]omethane																										
Carbon disulfide	36	2	11	15	5.6	2.9	1.5	11	8.7	9.6	4.1	7.6	4.4		3.2	2.7	5.6	6.4	0.0057	0.0087	0.0092		0.01	0.0093		
Carbon tetrachloride												3.6														
Chlorobenzene	78000	10	41	940	310	3900	18000	64	120	64	180	3.9	240	2500	95	25000	3	13	0.14	0.91	2.1	18	0.032	0.015	2	20
Chloroethane	86																									
Chloroform	9200	2				2.5																				
Chloromethane			1.8			3.3											3.4		0.025							
cis-1,3-Dichloropropene																										
Dibromochloromethane																										
Dibromomethane																										
Dichlorodifluoromethane																							0.0043			
Ethanol																										
Ethyl methacrylate																								0.0074		
Ethylbenzene	4		3.3	2.3				2.5							18	420		1.3	0.0081	0.053			0.012	0.06		
Iodomethane																										
Methylene chloride	140000	51	24	14	5.4	390	600	15	7.1	7.2	5	6.8	21	4.3	25	24	8.2	3.2	0.005	0.017	0.021	0.0055	0.0077	0.0063	0.0069	
Styrene																			0.5	0.33						
Tetrachloroethene	83000	11	7.9	16	5.5		17	5.8	3.6		89	87	11	7.3	2.1	12		33					0.0022			
Toluene	980	6	12	3.6		2.9	2.1	150	3	2.7	15	8.5	63	150	760	3.1	15	1.4	0.034	0.021		0.013	0.0025	0.0013		
trans-1,2-Dichloroethene							1.5																			
trans-1,3-Dichloropropene																										
trans-1,4-Dichloro-2-butene																										
Trichlorethene	4100		16	77	4.1	1.7	1.9	1.9			13	16	3.8	2.4		3.7					0.0019					
Trichlorofluoromethane																							0.0035			
Vinyl acetate	.9																									
Vinyl chloride						15													0.0028	0.0013						
Xylenes (total)	1000	6		3.4	2.3			1.7			2.2	2.4	2.6			770				0.0061		0.0031	0.0094	0.0024		
volatile Organics (mg/kg)																										
1,2,4,5-Tetrachloro-benzene																										

TABLE 5-10
COMPARISON OF LONG-TERM MONITORING MAXIMUM ANALYTE CONCENTRATIONS WITH RI RESULTS IN SEDIMENT

Analytes	Phase I RI	Phase II RI	1qtr1yr (Nov 1994)		2qtr1yr (Jan 1995)		3qtr1yr (Apr 1995)		4qtr1yr (Jul 1995)		1qtr2yr (Oct 95)		2qtr2yr (Mar 96)		3qtr2yr (May 96)		4qtr2yr (Aug 96)		1Evnt3Yr (Jul 97)		2Evnt3Yr (Jan 97)		1Evnt4Yr (Jul 98)		2Evnt4Yr (Jan 98	
			0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in
1,2,4-Trichlorobenzene															140	51										
1,2-Dichlorobenzene	3100		340	200	250	570	850	2200	310		44		3000		1600	670	3600			1.2	0.22	0.13	0.92	0.19	1.4	11
1,3-Dichlorobenzene	280							100							150	1800	520					0.38			0.15	1.1
1,4-Dichlorobenzene	4400		60			210		280		46			2400		250	4100	1200		0.051		0.13	1.1		0.1	0.89	6.3
1-Chloronaphthalene			250	5200	610	2400		3500	1300	960	390	420	1500	2600	260	470	350		0.046	0.23	0.16	0.06	38	0.25	0.89	3.7
1-Naphthylamine																										
2,3,4,6-Tetrachlorophenol																										
2,4,5-Trichlorophenol																										
2,4,6-Trichlorophenol																										
2,4-Dichlorophenol	160																									
2,4-Dimethylphenol			84		50					350					180						0.064		0.062			
2,4-Dinitrophenol																										
2,4-Dinitrotoluene																										
2,6-Dichlorophenol																										
2,6-Dinitrotoluene																										
2-Chloronaphthalene	1600			700		210		350	1400	1000	310	600		310		2100	280		0.22	0.053	0.5	0.29	0.082		0.078	0.71
2-Chlorophenol																										
2-Methylnaphthalene	1900		110	150		100	410	1000	1200	100	460		4000		460	10000	610		0.28	0.41	0.47	4.5	0.071		0.095	1.6
2-Methylphenol	68																						0.083			
2-Naphthylamine																										
2-Nitrophenol																										
2-Picoline																										
3,3'-Dichlorobenzidine	1700																									
thylcholanthrene													1300			1000					0.25					
..troaniline																										
3/4-Methylphenol			88			58	140		160	220			440	60												
4,6-Dinitro-2-methylphenol											17000															
4-Aminobiphenyl																										
4-Bromophenyl phenyl ether																										
4-Chloro-3-methylphenol																										
4-Chloroaniline																										
4-Chlorophenyl phenyl ether																										
4-Nitroaniline																										
4-Nitrophenol																	230	570								
7,12-Dimethylbenz(a)-anthracene																										
a,a-Dimethylphenethyl-amine																										
Acenaphthene	1100		410	3100	260	490	1600	1800	8000	510	4200	2000	17000	500	1900	15000	3100	710	2	0.86	2.2	0.28	2.4	2.2	0.42	1.3
Acenaphthylene									44								360				0.043		0.06		0.09	0.52
Acetophenone																					0.11		0.53			
Aniline																										
Anthracene	1500		830	4800	620	1400	5800	4400	26000	840	11000	1100	36000	2400	3600	29000	5000	2600	3.2	1.9	4.4	0.44	12	7.7	1.1	5
Azobenzene																							0.53			
Benzidine				160			430				350						290						0.11	0.094		
Benzo(a)anthracene	4800		2900	15000	2100	3000	11000	13000	39000	3200	26000	2100	59000	6200	11000	46000	16000	6300	9.9	4.7	7.1	1.7	46	34	8	10
Benzo(a)pyrene	4400		2600	14000	2200	3100	9800	11000	26000	3200	26000	1900	45000	4700	10000	35000	14000	6200	11	5	9.3	1.9	63	39	9.3	7.2
Benzo(b)fluoranthene	9200		6100	28000	4000	6000	19000	20000	9800	6600	49000	3300	83000	8300	20000	43000	27000	9300	13	5.9	11	2.3	55	40	13	7.3
Benzo(g,h,i)perylene	4100		1800	1200	1300	1700	7600	6800	17000	1900	20000	1100	19000	2000	5400	16000	10000	3600	5.3	2.1	4.3	0.96	60	34	8.9	4
Benzo(k)fluoranthene	5300		2400	670	2800	110	15000	81	39000	2600	210	2100		250	410	23000	7400	320	8.6	5.5	12	2	59	33	8.3	5.9
Benzoic acid			170				70						56	69	50						0.28		1.8			
Benzyl alcohol													79													
bis(2-Chloroethoxy)methane																										
bis(2-Chloroethyl)ether																										
-Chloroisopropyl)ether																										
bis(2-Ethylhexyl)phthalate	46000		7000	7800	8000	11000	7800	23000			7800	5500	11000	24000	6500	22000	4500	8900	7.5	19	13	14	16	4.2	5.2	5.5

TABLE 5-10
COMPARISON OF LONG-TERM MONITORING MAXIMUM ANALYTE CONCENTRATIONS WITH RI RESULTS IN SEDIMENT

Analytes	Phase I RI	Phase II RI	1qtr1yr (Nov 1994)		2qtr1yr (Jan 1995)		3qtr1yr (Apr 1995)		4qtr1yr (Jul 1995)		1qtr2yr (Oct 95)		2qtr2yr (Mar 96)		3qtr2yr (May 96)		4qtr2yr (Aug 96)		1Evnt3Yr (Jul 97)		2Evnt3Yr (Jan 97)		1Evnt4Yr (Jul 98)		2Evnt4Yr (Jan 9	
			0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 in	0-6 in	6-12 i
Butyl benzyl phthalate	720		6000				4900		560		230						71		0.47		0.51		0.068			
Chrysene	7100		5200	19000	2600	3300	15000	15000	35000	5000	33000	21000	57000	5900	12000	42000	18000	7200	12	6.3	12	2.3	66	47	12	12
Di-n-butyl phthalate	2200		150	150	130	150				4600	59				54		510		0.2		0.068	0.05	0.47		0.053	
Di-n-octyl phthalate	540		410	400		520	180	11000	700		500	56	1400	8900		210	84	630	0.66	0.5			0.51		0.13	
Dibenz(a,h,)anthracene	110		750	420	150		1600	1300			1300	2100	6000	570	1100	4100	770	840	1.9	0.9	1.5	0.36	15	11	2.7	0.62
Dibenz(a,j)acridine									1400	89									0.33				0.2	0.94		
Dibenzofuran	480		250	1500	160	340	1000	1000	5500	310	2500	1600	11000	360	1200	8000	1600		1.2	0.79	1.5	0.18	0.8	1.4	0.22	0.75
Diethyl phthalate											120					160										
Dimethyl phthalate					57				660	530	300		86	280												
Diphenylamine																										
Ethyl methanesulfonate																										
Fluoranthene	11000		6400	3800	6300	8100	25000	23000	53000	8000	100000	85000	120000	14000	35000	120000	30000	14000	32	18	24	6.5	160	100	27	26
Fluorene	880		410	2600	300	560	2400	2200	12000	530	5900	3600	23000	820	1700	16000	2700	620	2.2	1.2	2.5	0.28	4.2	3.5	0.42	1.6
Hexachlorobenzene																										
Hexachlorobutadiene																										
Hexachlorocyclopentadiene																										
Hexachloroethane																										
Indeno(1,2,3-cd)pyrene	3800		1700	4600	1100	1600	6100	5600	19000	1700	14000	8200	20000	1900	4700	15000	8900	3400	4.7	2.2	4.5	1	49	31	7.9	3.9
Isophorone							98			57												0.47				
Methyl methanesulfonate																										
N-Nitroso-di-n-butylamine																										
N-Nitroso-di-n-propylamine																										
N-Nitrosodiphenylamine						150	50								47											
N-Nitrosopiperidine																										
Naphthalene	690		1000	860	1100	3700	980	1600	5900	800	2500	1100	15000	690	2200	4100	2700	520	1.4	1.7	2.1	4	9.4	9.4	3.9	3.4
Nitrobenzene																										
p-Dimethylaminoazobenzene																										
Pentachlorobenzene																										
Pentachloronitrobenzene																										
Pentachlorophenol					55												490									
Phenacetin																										
Phenanthrene	6700		3800	3700	3300	6200	22000	14000	58000	5200	73000	5800	110000	7100	18000	110000	28000	9100	21	11	16	3.5	70	51	7.1	16
Phenol					63																		0.086			0.046
Pronamide																										
Pyrene	10000		7800	55000	4500	6400	26000	33000	51000	7100	80000	5800	110000	14000	27000	88000	28000	11000	25	11	16	2.9	120	80	20	19

TABLE 5-11
STATISTICAL EVALUATION OF ANALYTES DETECTED IN SURFACE WATER SAMPLES
FOURTH YEAR LONG-TERM MONITORING

COMPOUND NAME	NumOfResult	MinOfResult	MaxOfResult	AvgOfResult
Dissolved Metals (mg/L)				
Aluminum	12	0.0053	0.063	0.0164
Antimony	4	0.00041	0.00076	0.0006
Barium	16	0.22	0.42	0.3806
Cadmium	13	0.000049	0.0008	0.0003
Calcium	16	44.1	69.2	53.1188
Chromium	16	0.019	0.025	0.0223
Cobalt	16	0.000096	0.00058	0.0002
Copper	16	0.0015	0.061	0.0151
Iron	2	0.032	0.16	0.0960
Lead	10	0.000073	0.00034	0.0002
Magnesium	16	12.7	26.4	23.3188
Manganese	16	0.0003	0.14	0.0202
Molybdenum	12	0.0011	0.012	0.0029
Nickel	16	0.0026	0.033	0.0068
Potassium	15	1.5	2.2	1.8333
Selenium	16	0.00061	0.0033	0.0019
Silver	5	0.000078	0.0003	0.0002
Sodium	16	12.1	26.4	20.7063
Vanadium	16	0.0064	0.017	0.0152
Zinc	16	0.02	0.065	0.0289
PCBs & Pesticides (ug/L)				
Dieldrin	1	0.029	0.029	0.029
Heptachlor	1	0.024	0.024	0.024
Semivolatile Organic Compounds (mg/L)				
bis(2-Ethylhexyl)phthalate	4	0.0018	0.14	0.037
Di-n-butyl phthalate	3	0.0015	0.002	0.002
Total Metals (mg/L)				
Aluminum	30	0.006	0.88	0.1830
Antimony	17	0.0002	0.0019	0.0006
Arsenic	1	0.0061	0.0061	0.0061
Barium	30	0.22	0.52	0.4057
Beryllium	3	0.000068	0.00012	0.0001
Cadmium	29	0.000077	0.01	0.0012
Calcium	30	34.2	62.9	46.6333
Chromium	30	0.00026	0.025	0.0084
Cobalt	30	0.000092	0.00089	0.0003
Copper	30	0.0026	0.14	0.0365
Iron	25	0.025	1.2	0.3399

TABLE 5-11
STATISTICAL EVALUATION OF ANALYTES DETECTED IN SURFACE WATER SAMPLES
FOURTH YEAR LONG-TERM MONITORING

COMPOUND NAME	NumOfResult	MinOfResult	MaxOfResult	AvgOfResult
Lead	30	0.00028	0.0091	0.0020
Magnesium	30	11.5	26.5	21.0433
Manganese	30	0.00086	0.16	0.0311
Mercury	4	0.000044	0.000075	0.0001
Molybdenum	30	0.00018	0.011	0.0020
Nickel	30	0.002	0.036	0.0062
Potassium	30	0.95	4.7	1.7783
Selenium	30	0.00034	0.0039	0.0012
Silver	5	0.000081	0.00036	0.0003
Sodium	30	9.4	36.3	18.5667
Thallium	19	0.000028	0.000075	0.000043
Vanadium	30	0.0014	0.016	0.0119
Zinc	30	0.016	0.079	0.0355
Volatile Organic Compounds (mg/L)				
Acetone	15	0.0012	0.0051	0.0028
Bromoform	3	0.001	0.0014	0.0012
Methylene chloride	21	0.001	0.0031	0.0017
Tetrachloroethene	2	0.0014	0.0015	0.0015
Wet Chemistry (mg/L)				
Alkalinity, Bicarb. as CaCO3 at pH 4.5	16	165	225	191.00
Alkalinity, Carb. as CaCO3 at pH 8.3	6	5.9	17.2	11.12
Alkalinity, Total as CaCO3 at pH 4.5	30	165	234	197.10
Chemical Oxygen Demand (COD)	1	12.4	12.4	12.40
Chemical Oxygen Demand (Regular)	3	9.9	29.9	17.20
Chloride	30	6.4	54	16.38
Hardness as CaCo3	30	156	234	197.07
Sulfate	30	4.5	88.7	21.03
Total Dissolved Solids	30	104	437	256.33
Total Organic Carbon	28	0.29	4.8	2.04
Total Suspended Solids	14	1.6	68.8	11.17
Total Organic Carbon	28	0.29	4.8	2.04
Total Suspended Solids	14	1.6	68.8	11.17

TABLE 5-12
MAXIMUM DETECTED CONCENTRATIONS AND ASSOCIATED SAMPLE LOCATIONS
FOR ANALYTES DETECTED IN SURFACE WATER
FOURTH YEAR LONG-TERM MONITORING

COMPOUND NAME	SAMPLE_ID	RESULT	DETECTION LIMIT	FOOTNOTES	DATE COLLECTED
Dissolved Metals (mg/L)					
Aluminum	QE07-SW-1101	0.063	0.05		1/21/98
Antimony	QE05-SW-1101	0.00076	0.001	J	01/22/98
Barium	QE03-SW-1101	0.42	0.001		01/23/98
Barium	QE04-SW-1101	0.42	0.001		01/23/98
Barium	QE07-SW-1101	0.42	0.001		1/21/98
Barium	QE08-SW-1101	0.42	0.001		01/22/98
Cadmium	QW04-SW-1101	0.00075	0.001	J	01/20/98
Calcium	QW07-SW-1101	69.2	0.2		1/21/98
Chromium	QW05-SW-1101	0.025	0.001		01/19/98
Cobalt	QW03-SW-1101	0.00058	0.001	J	01/20/98
Copper	QE02-SW-1101	0.061	0.001		01/23/98
Iron	QE11-SW-1101	0.16	0.1		01/20/98
Lead	QE11-SW-1101	0.00034	0.001	J	01/20/98
Magnesium	QE03-SW-1101	26.4	0.2		01/23/98
Manganese	QW07-SW-1101	0.14	0.001		1/21/98
Molybdenum	QW04-SW-1101	0.012	0.001		01/20/98
Nickel	QW03-SW-1101	0.033	0.001		01/20/98
Potassium	QE02-SW-1101	2.2	5	J	01/23/98
Potassium	QE06-SW-1101	2.2	5	J	01/22/98
Selenium	QE04-SW-1101	0.0033	0.005	J	01/23/98
Silver	QE07-SW-1101	0.0003	0.001	J	1/21/98
Silver	QE09-SW-1101	0.0003	0.001	J	1/21/98
Sodium	QE03-SW-1101	26.4	5		01/23/98
Vanadium	QE01-SW-1101	0.017	0.005		01/23/98
Vanadium	QE02-SW-1101	0.017	0.005		01/23/98
Vanadium	QE03-SW-1101	0.017	0.005		01/23/98
Vanadium	QE04-SW-1101	0.017	0.005		01/23/98
Vanadium	QE05-SW-1101	0.017	0.005		01/22/98
Vanadium	QE07-SW-1101	0.017	0.005		1/21/98
Vanadium	QE08-SW-1101	0.017	0.005		01/22/98
Vanadium	QE09-SW-1101	0.017	0.005		1/21/98
Vanadium	QE10-SW-1101	0.017	0.005		01/20/98
Vanadium	QW05-SW-1101	0.017	0.005		01/19/98
Zinc	QW03-SW-1101	0.065	0.01		01/20/98
PCBs & Pesticides (ug/L)					
Dieldrin	QE07-SW-1201	0.029	0.1	J	07/22/98
Heptachlor	QE07-SW-1201	0.024	0.05	J	07/22/98
Semivolatile Organic Compounds (mg/L)					
bis(2-Ethylhexyl)phthalate	QE02-SW-1101	0.14	0.0095		01/23/98
Di-n-butyl phthalate	QW06-SW-1201	0.002	0.01	J	07/20/98
Total Metals (mg/L)					
Aluminum	QE06-SW-1201	0.88	0.05		07/22/98
Antimony	QE11-SW-1201	0.0019	0.001		07/21/98
Arsenic	QW06-SW-1201	0.0061	0.01	B	07/20/98
Barium	QE01-SW-1201	0.52	0.001		07/23/98
Beryllium	QW06-SW-1201	0.00012	0.001	B	07/20/98
Cadmium	QE07-SW-1201	0.01	0.001		07/22/98
Calcium	QW07-SW-1101	62.9	0.2		1/21/98

TABLE 5-12
MAXIMUM DETECTED CONCENTRATIONS AND ASSOCIATED SAMPLE LOCATIONS
FOR ANALYTES DETECTED IN SURFACE WATER
FOURTH YEAR LONG-TERM MONITORING

COMPOUND NAME	SAMPLE_ID	RESULT	DETECTION LIMIT	FOOTNOTES	DATE COLLECTED
Chromium	QE09-SW-1201	0.025	0.001		07/21/98
Cobalt	QE06-SW-1201	0.00089	0.001	B	07/22/98
Copper	QE02-SW-1201	0.14	0.001		07/23/98
Iron	QE10-SW-1201	1.2	0.1		07/21/98
Lead	QE06-SW-1201	0.0091	0.001		07/22/98
Lead	QE07-SW-1201	0.0091	0.001		07/22/98
Magnesium	QE03-SW-1101	26.5	0.2		01/23/98
Manganese	QW07-SW-1101	0.16	0.001		1/21/98
Mercury	QW04-SW-1101	0.000075	0.0002	J	01/20/98
Molybdenum	QW04-SW-1101	0.011	0.001		01/20/98
Nickel	QW03-SW-1101	0.036	0.001		01/20/98
Potassium	QW07-SW-1201	4.7	5	B	07/20/98
Selenium	QE11-SW-1101	0.0039	0.005	J	01/20/98
Silver	QE07-SW-1201	0.00036	0.001	B	07/22/98
Sodium	QE05-SW-1201	36.3	5		07/22/98
Thallium	QW05-SW-1201	0.000075	0.001	B	07/20/98
Vanadium	QE01-SW-1201	0.016	0.005		07/23/98
Zinc	QW03-SW-1101	0.079	0.01		01/20/98
Volatile Organic Compounds (mg/L)					
Acetone	QW07-SW-1101	0.0051	0.01	J	1/21/98
Bromoform	QE05-SW-1101	0.0014	0.005	J	01/22/98
Methylene chloride	QW04-SW-1101	0.0031	0.005	JB	01/20/98
Tetrachloroethene	QE09-SW-1101	0.0015	0.003	J	1/21/98
Wet Chemistry (mg/L)					
Alkalinity, Bicarb. as CaCO3 at pH 4.5	QW05-SW-1101	225	5	B	01/19/98
Alkalinity, Carb. as CaCO3 at pH 8.3	QE10-SW-1101	17.2	5		01/20/98
Alkalinity, Total as CaCO3 at pH 4.5	QW05-SW-1201	234	5		07/20/98
Chemical Oxygen Demand (COD)	QW07-SW-1201	12.4	10		07/20/98
Chemical Oxygen Demand (Regular)	QE06-SW-1101	29.9	20		01/22/98
Chloride	QE03-SW-1201	54	3		07/23/98
Hardness as CaCO3	QE03-SW-1101	234	5		01/23/98
Sulfate	QE03-SW-1101	88.7	0.5		01/23/98
Total Dissolved Solids	QE01-SW-1201	437	10		07/23/98
Total Organic Carbon	QW07-SW-1101	4.8	1		1/21/98
Total Suspended Solids	QE01-SW-1101	68.8	2		01/23/98

TABLE 5-13
COMPARISON OF LONG-TERM MONITORING MAXIMUM ANALYTE CONCENTRATIONS
WITH RI RESULTS IN SURFACE WATER

Analytes	Phase I RI	Phase II RI	1Qtr1Yr (Nov 1994)	2Qtr1Yr (Jan 1995)	3Qtr1Yr (Apr 1995)	4Qtr1Yr (Jul 1995)	1Qtr2Yr (Oct 95)	2Qtr2Yr (Mar 96)	3Qtr2Yr (May 96)	4Qtr2Yr (Aug 96)	1Evnt3Yr (Jan 97)	2Evnt3Yr (Jul 97)	1Evnt4Yr (Jan 98)	2Evnt4Yr (Jul 98)
Metals (mg/L)														
Aluminum	7.43		4.3	0.55	0.7	0.15	0.053	0.038	0.18	0.21	0.06	0.73	0.063	0.88
Antimony							0.046	0.00091	0.00037	0.00051	0.00055		0.00076	0.0019
Arsenic	0.0098		0.0026	0.0035	0.0024	0.0031	0.0015	0.0033	0.0033	0.0029	0.0027	0.0038		0.0061
Barium	1.9		0.61	0.46	0.44	0.68	0.54	0.37	0.49	0.65	0.55	0.62	0.42	0.52
Beryllium	0.001								0.00068	0.00014				0.00012
Boron														
Cadmium	0.0569	0.0094	0.0036	0.0061				0.001	0.0034	0.0053	0.0012	0.016	0.00075	0.01
Calcium	117		92.4	74.4	61.2	99.6	103	67.9	103	91.1	72.4	66.9	69.2	48.5
Chromium	0.628	0.0369	0.039	0.52	0.031	0.056	0.014	0.0097	0.015	0.02	0.014	0.045	0.025	0.025
Cobalt	0.324		0.031	0.0068	0.008			0.0012	0.0017	0.00054	0.0018	0.001	0.00058	0.00089
Copper	0.985		0.11	0.08	0.098	0.3	0.27	0.049	0.14	0.36	0.083	0.51	0.061	0.14
Iron	4.55		3.4	1.3	1.4	0.28	0.12	1.5	1.7	1.1	0.44	1.9	0.16	1.2
Lead	0.325	0.0345	0.0066	0.03	0.0054	0.0048	0.0028	0.0035	0.016	0.0001	0.0016	0.015	0.00034	0.0091
Magnesium	40.8		44.3	33.3	29.9	45.7	47.2	32.5	49.8	44.7	36.1	33.3	26.4	24.1
Manganese	3.06		0.35	0.13	0.44	0.14	0.086	0.12	0.23	0.091	0.067	0.24	0.14	0.092
Mercury				0.00018										
Molybdenum			0.57	0.42	0.2	0.3	0.5	0.29	0.56	0.013	0.02	0.0026	0.12	0.0036
Nickel	3.56		0.33	0.093	0.033	0.016	0.011	0.032	0.049	0.015	0.052	0.013	0.33	0.015
Potassium	6.68		5.7	5	4.5	5.7	5.4	9.6	6.2	3.6	2.3	10.1	2.2	4.7
Selenium	0.0209		0.0036	0.0041	0.0041	0.0024	0.0027	0.0028	0.021	0.0042	0.0042	0.0018	0.0033	0.0016
Silver	0.0131										0.00013	0.00062	0.0003	0.00036
Sodium	130		203	106	123	111	179	200	114	68	29.3	29.8	26.4	36.3
Thallium					0.0012									7.5E-06
Tin														
Vanadium	0.067		0.028	0.018	0.017	0.03	0.026	0.019	0.026	0.023	0.018	0.017	0.017	0.016
Zinc	2.4		0.068	0.044	0.034	0.032	0.055	0.076	0.1	0.026	0.036	0.075	0.065	0.056
PCB's and Chlorinated Pesticides (ug/L)														
4,4'-DDD														
4,4'-DDE														
4,4'-DDT								0.075						
Aldrin				0.086										
alpha-BHC														
alpha-Chlordane														
Aroclor 1016														
Aroclor 1221														
Aroclor 1232														
Aroclor 1242														
Aroclor 1248														
Aroclor 1254											0.58			

TABLE 5-13
COMPARISON OF LONG-TERM MONITORING MAXIMUM ANALYTE CONCENTRATIONS
WITH RI RESULTS IN SURFACE WATER

Analytes	Phase I RI	Phase II RI	1Qtr1Yr (Nov 1994)	2Qtr1Yr (Jan 1995)	3Qtr1Yr (Apr 1995)	4Qtr1Yr (Jul 1995)	1Qtr2Yr (Oct 95)	2Qtr2Yr (Mar 96)	3Qtr2Yr (May 96)	4Qtr2Yr (Aug 96)	1Evnt3Yr (Jan 97)	2Evnt3Yr (Jul 97)	1Evnt4Yr (Jan 98)	2Evnt4Yr (Jul 98)
Aroclor 1260														
beta-BHC														
delta-BHC														
Dieldrin														0.029
Endosulfan I														
Endosulfan II														
Endosulfan sulfate														
Endrin														
gamma-BHC (Lindane)														
gamma-Chlordane														
Heptachlor														0.024
Heptachlor epoxide														
Methoxychlor														
Toxaphene														
Volatile Organics (mg/L)														
1,1,1,2-Tetrachloroethane														
1,1,1-Trichloroethane	2	5												
1,1,2,2-Tetrachloroethane														
1,1,2-Trichloroethane		2												
1,1-Dichloroethane														
1,1-Dichloroethene														
1,2,3-Trichloropropane														
1,2-Dichloroethane														
1,2-Dichloropropane														
2-Butanone (MEK)			2.8				5.4			2.7	0.0062			
2-Chlorethyl vinyl ether														
2-Hexanone										5.4				
4-Methyl-2-pentanone (MIBK)														
Acetone	5	60	11	4.6	8.4	12	26	4.4	12	24	0.0072	0.012	0.0051	0.0031
Acrolein											0.0025			
Acrylonitrile											0.0027			
Benzene		2												
Bromodichloromethane	6	0.9												
Bromoform	4	15	1.9		2.6	1.8	4.0		1.9	2.6	0.0016		0.0014	
Bromomethane											0.0072			
Carbon disulfide		1		1				4	2.5					
Carbon tetrachloride														
Chlorobenzene		2		1.8										
Chloroethane														
Chloroform	6	9		1.8					1.0					
Chloromethane											0.0036			

TABLE 5-13
COMPARISON OF LONG-TERM MONITORING MAXIMUM ANALYTE CONCENTRATIONS
WITH RI RESULTS IN SURFACE WATER

Analytes	Phase I RI	Phase II RI	1Qtr1Yr (Nov 1994)	2Qtr1Yr (Jan 1995)	3Qtr1Yr (Apr 1995)	4Qtr1Yr (Jul 1995)	1Qtr2Yr (Oct 95)	2Qtr2Yr (Mar 96)	3Qtr2Yr (May 96)	4Qtr2Yr (Aug 96)	1Evnt3Yr (Jan 97)	2Evnt3Yr (Jul 97)	1Evnt4Yr (Jan 98)	2Evnt4Yr (Jul 98)
cis-1,3-Dichloropropene														
Dibromochloromethane	5									1.1	0.0018			
Dibromomethane														
Dichlorodifluoromethane							2.4							
Ethanol											0.041			
Ethyl methacrylate														
Ethylbenzene														
Iodomethane											0.0018			
Methylene chloride	14	620	11	150	2.8	5.1	150	2.3	2.3	12	0.0059	0.0014	0.0031	0.0022
Styrene											0.0034			
Tetrachloroethene	3	6	11	7.6	2.1				1.5				0.0015	
Toluene	1	5		1.4					3.6					
trans-1,2-Dichloroethene														
trans-1,3-Dichloropropene														
trans-1,4-Dichloro-2-butene														
Trichlorethene			3.1	14	1.6			9.4	13					
Trichlorofluoromethane														
Vinyl acetate														
Vinyl chloride					1									
Xylenes (total)		2												
Semivolatile Organics (mg/L)														
1,2,4,5-Tetrachloro-benzene														
1,2,4-Trichlorobenzene														
1,2-Dichlorobenzene							1.7			1.0				
1,3-Dichlorobenzene														
1,4-Dichlorobenzene														
1-Chloronaphthalene														
1-Naphthylamine														
2,3,4,6-Tetrachlorophenol														
2,4,5-Trichlorophenol														
2,4,6-Trichlorophenol										0.96				
2,4-Dichlorophenol														
2,4-Dimethylphenol														
2,4-Dinitrophenol														
2,4-Dinitrotoluene														
2,6-Dichlorophenol										2.8				
2,6-Dinitrotoluene														
2-Chloronaphthalene														
2-Chlorophenol										1.4				
2-Methylnaphthalene														
2-Methylphenol														

TABLE 5-13
COMPARISON OF LONG-TERM MONITORING MAXIMUM ANALYTE CONCENTRATIONS
WITH RI RESULTS IN SURFACE WATER

Analytes	Phase I RI	Phase II RI	1Qtr1Yr (Nov 1994)	2Qtr1Yr (Jan 1995)	3Qtr1Yr (Apr 1995)	4Qtr1Yr (Jul 1995)	1Qtr2Yr (Oct 95)	2Qtr2Yr (Mar 96)	3Qtr2Yr (May 96)	4Qtr2Yr (Aug 96)	1Evnt3Yr (Jan 97)	2Evnt3Yr (Jul 97)	1Evnt4Yr (Jan 98)	2Evnt4Yr (Jul 98)
2-Naphthylamine														
2-Nitrophenol														
2-Picoline														
3,3'-Dichlorobenzidine														
3-Methylcholanthrene														
3-Nitroaniline														
3/4-Methylphenol					1.3	1.7	1.2							
4,6-Dinitro-2-methylphenol														
4-Aminobiphenyl														
4-Bromophenyl phenyl ether														
4-Chloro-3-methylphenol														
4-Chloroaniline														
4-Chlorophenyl phenyl ether														
4-Nitroaniline														
4-Nitrophenol				1.7	2	1.2		1.3						
7,12-Dimethylbenz(a)-anthracene														
a,a-Dimethylphenethyl-amine														
Acenaphthene														
Acenaphthylene														
Acetophenone														
Aniline								4						
Anthracene														
Azobenzene														
Benzidine								1.2						
Benzo(a)anthracene														
Benzo(a)pyrene														
Benzo(b)fluoranthene														
Benzo(g,h,i)perylene	6													
Benzo(k)fluoranthene														
Benzoic acid	0.4				2.9	3.9	1.6	1.2	1.2	1.5				
Benzyl alcohol				1.7	1.2									
bis(2-Chloroethoxy)methane														
bis(2-Chloroethyl)ether														
bis(2-Chloroisopropyl)ether														
bis(2-Ethylhexyl)phthalate			1	3.6						1.3	0.013	0.14	0.14	
Butyl benzyl phthalate			1				3.2							
Chrysene	5													
Di-n-butyl phthalate										1.4			0.0015	0.002
Di-n-octyl phthalate														
Dibenz(a,h,)anthracene														
Dibenz(a,j)acridine														
Dibenzofuran										1.1				

TABLE 5-13
COMPARISON OF LONG-TERM MONITORING MAXIMUM ANALYTE CONCENTRATIONS
WITH RI RESULTS IN SURFACE WATER

Analytes	Phase I RI	Phase II RI	1Qtr1Yr (Nov 1994)	2Qtr1Yr (Jan 1995)	3Qtr1Yr (Apr 1995)	4Qtr1Yr (Jul 1995)	1Qtr2Yr (Oct 95)	2Qtr2Yr (Mar 96)	3Qtr2Yr (May 96)	4Qtr2Yr (Aug 96)	1Evnt3Yr (Jan 97)	2Evnt3Yr (Jul 97)	1Evnt4Yr (Jan 98)	2Evnt4Yr (Jul 98)
Diethyl phthalate						1.2	1.1							
Dimethyl phthalate								1		1.3				
Diphenylamine														
Ethyl methanesulfonate														
Fluoranthene	1			1.5				1.6		1.5				
Fluorene														
Hexachlorobenzene														
Hexachlorobutadiene														
Hexachlorocyclopentadiene														
Hexachloroethane														
Indeno(1,2,3-cd)pyrene														
Isophorone														
Methyl methanesulfonate														
N-Nitroso-di-n-butylamine														
N-Nitroso-di-n-propylamine														
N-Nitrosodiphenylamine														
N-Nitrosopiperidine														
Naphthalene										1.4				
Nitrobenzene														
p-Dimethylaminoazobenzene														
Pentachlorobenzene														
Pentachloronitrobenzene														
Pentachlorophenol														
Phenacetin														
Phenanthrene				1.6										
Phenol				3.5	2.7		2	2		1.4				
Pronamide														
Pyrene	1													

FIGURES

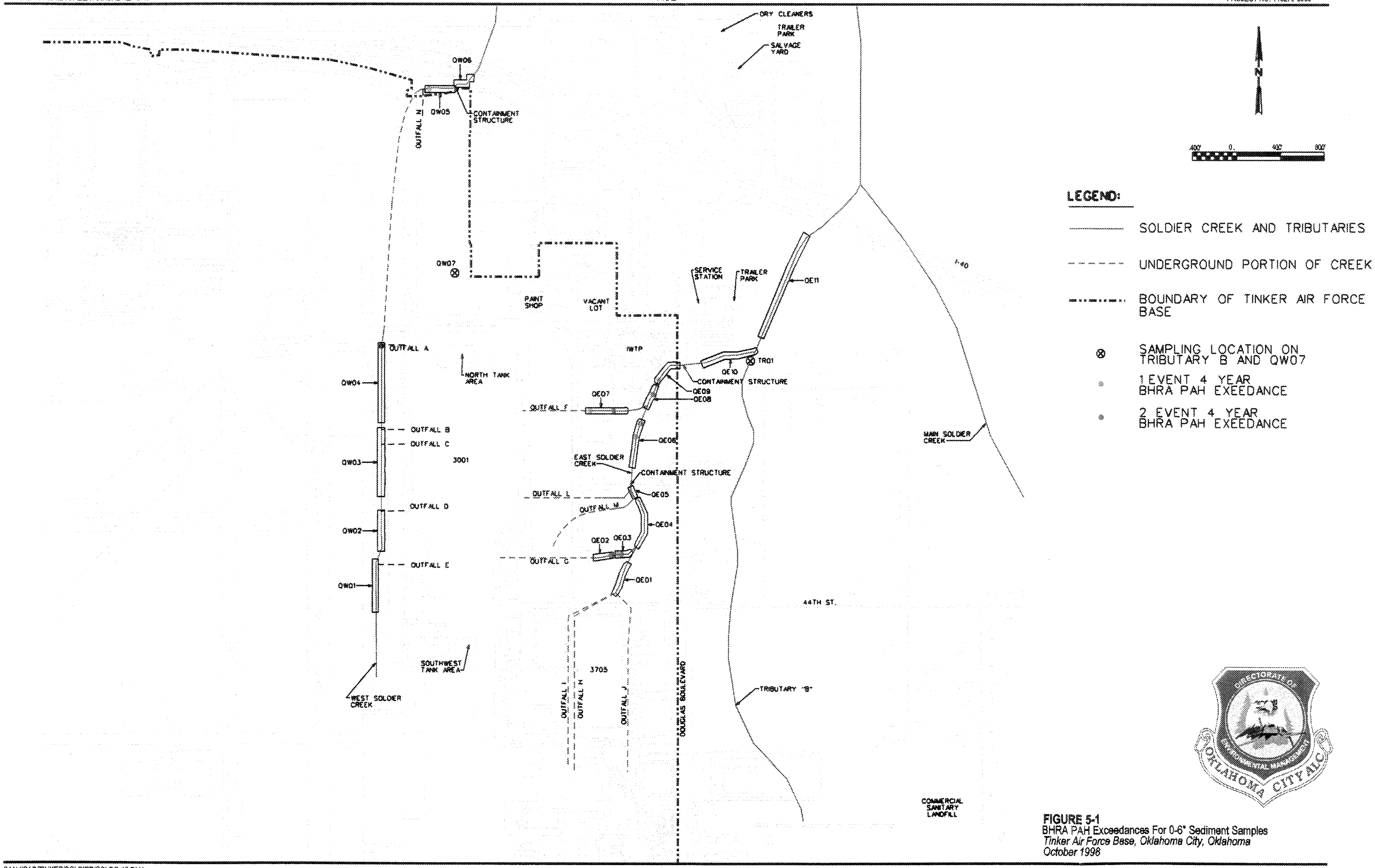


FIGURE 5-1
BHRA PAH Exceedances For 0-6" Sediment Samples
Tinker Air Force Base, Oklahoma City, Oklahoma
October 1998

FIGURE 5-2a
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

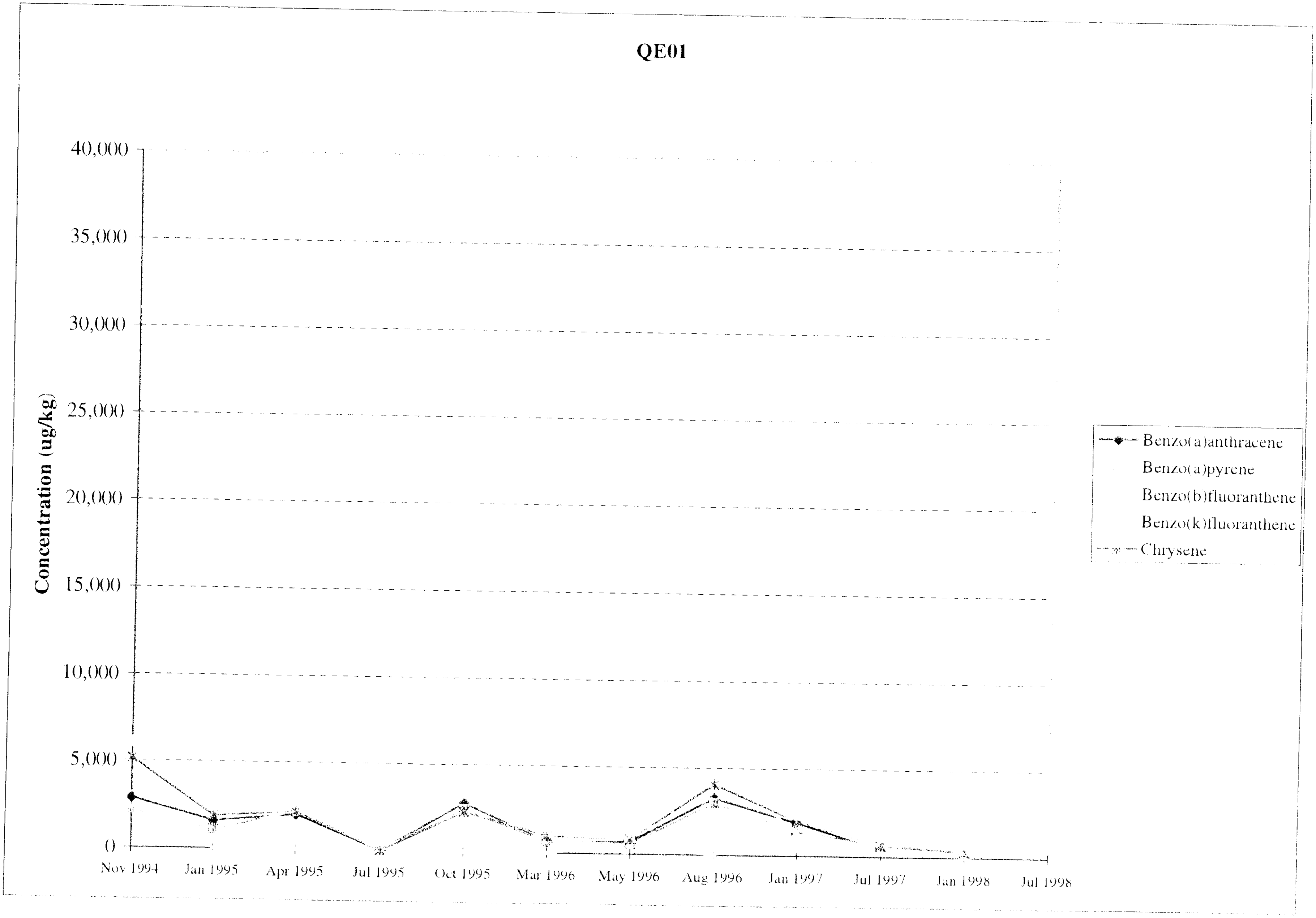


FIGURE 5-2b
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

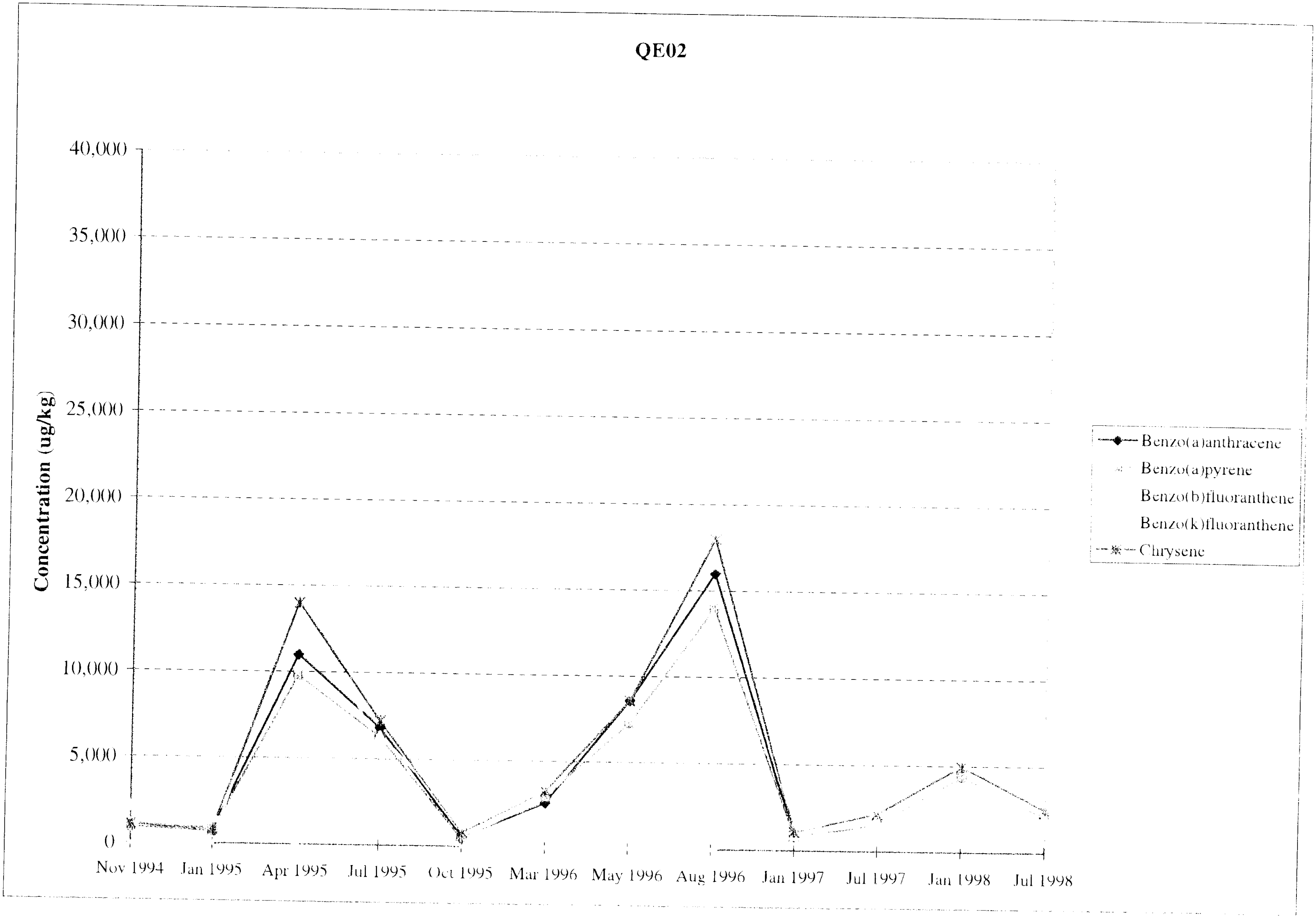


FIGURE 5-2c
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

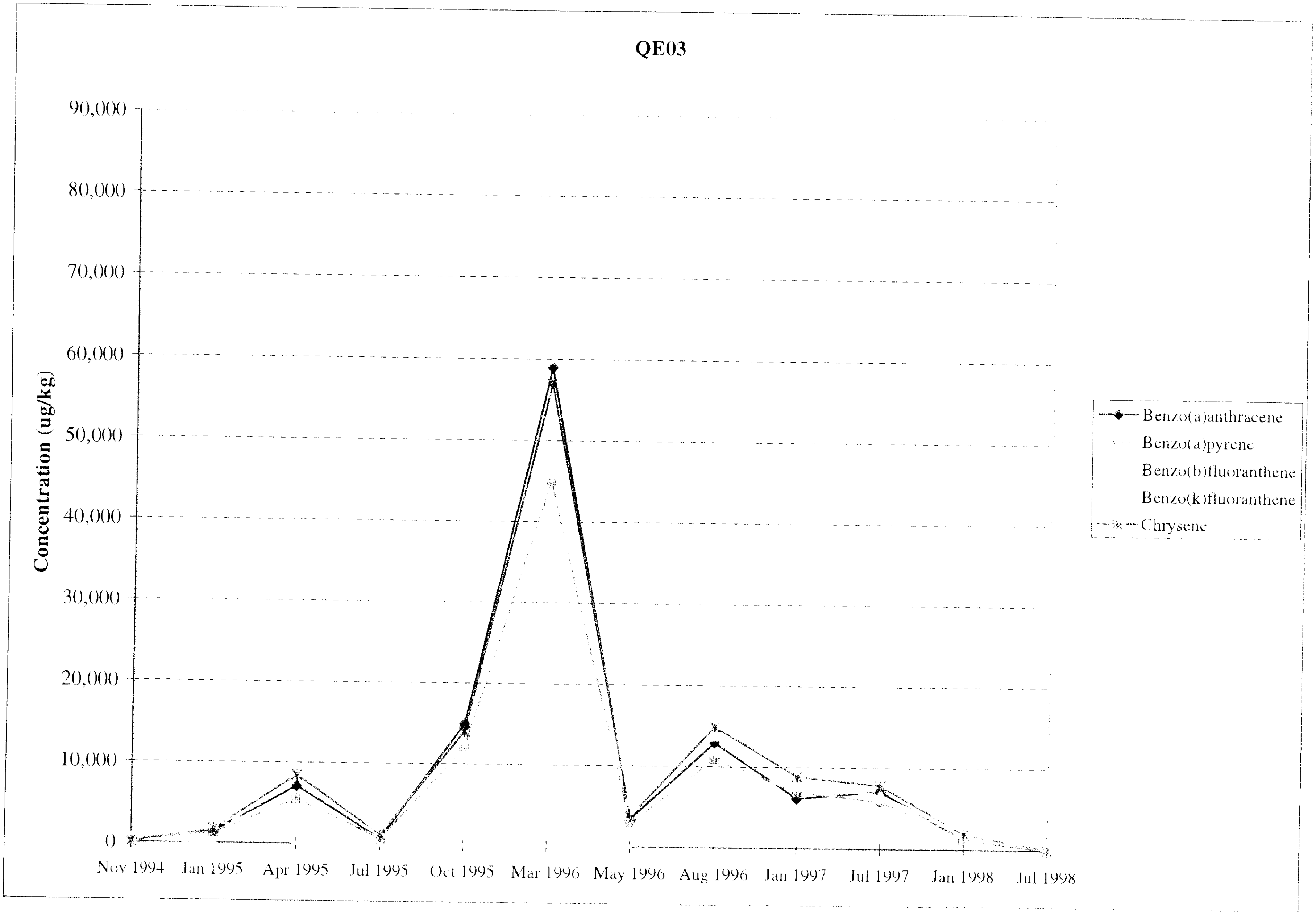


FIGURE 5-2d
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

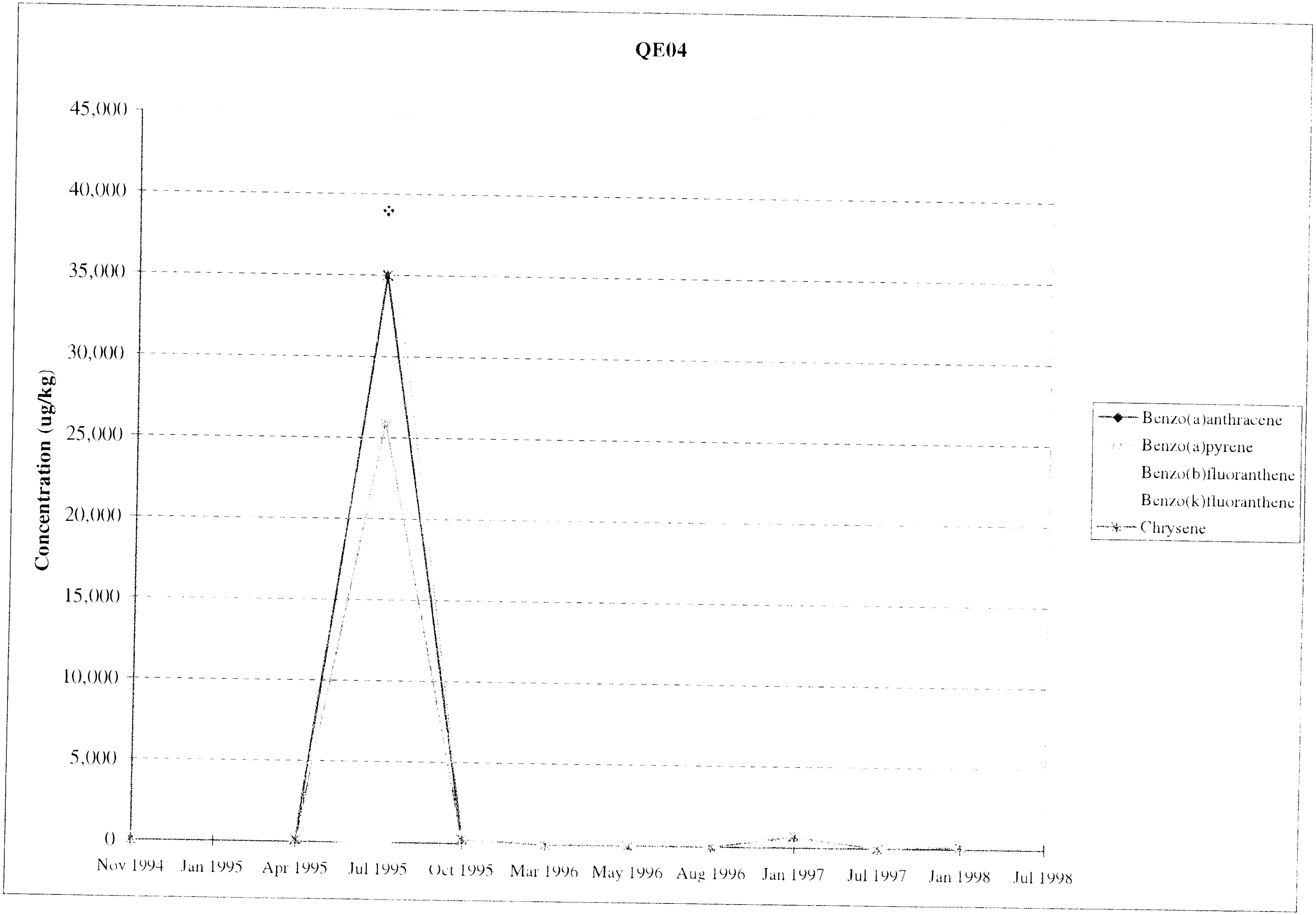


FIGURE 5-2e
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

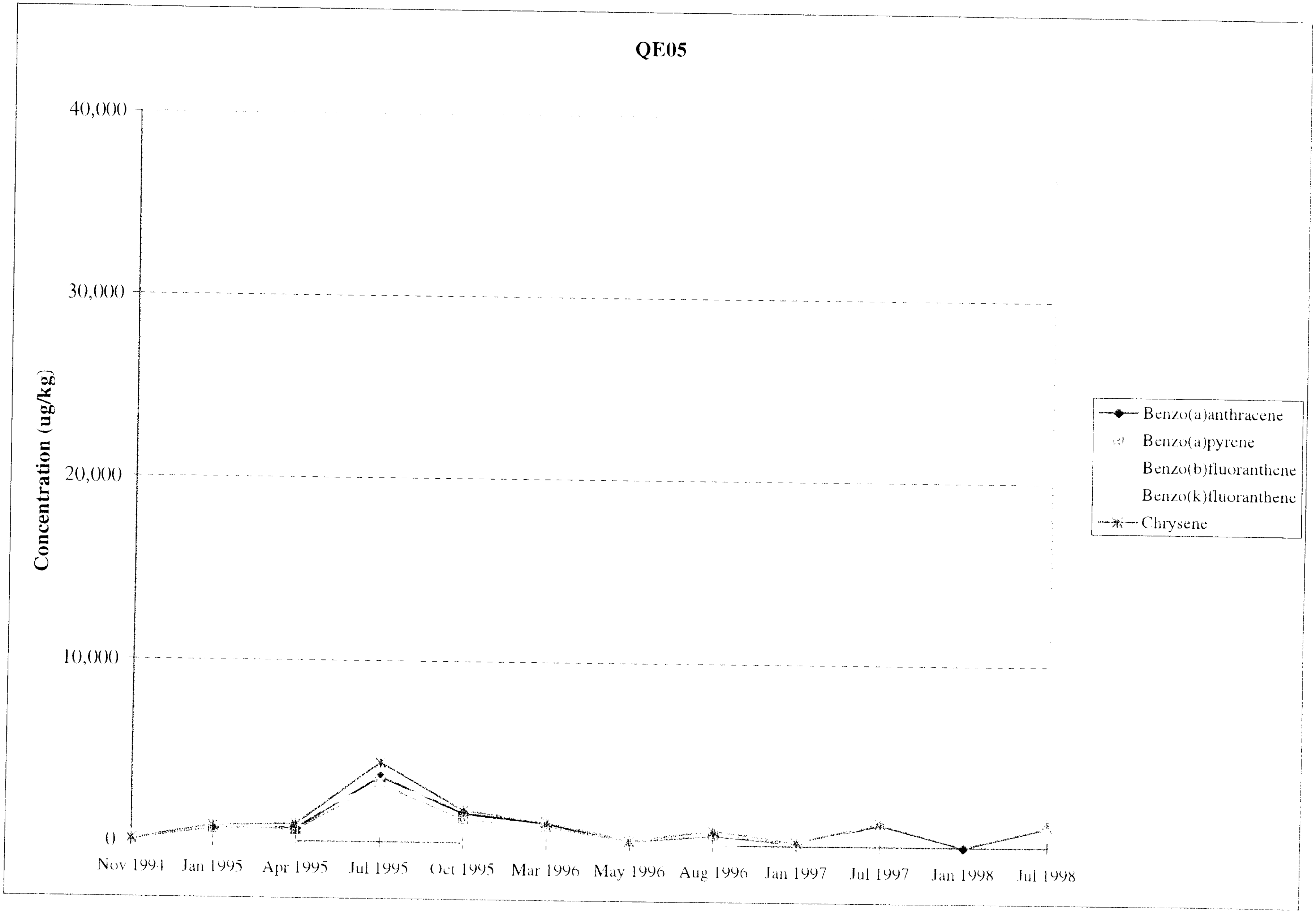


FIGURE 5-2f
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

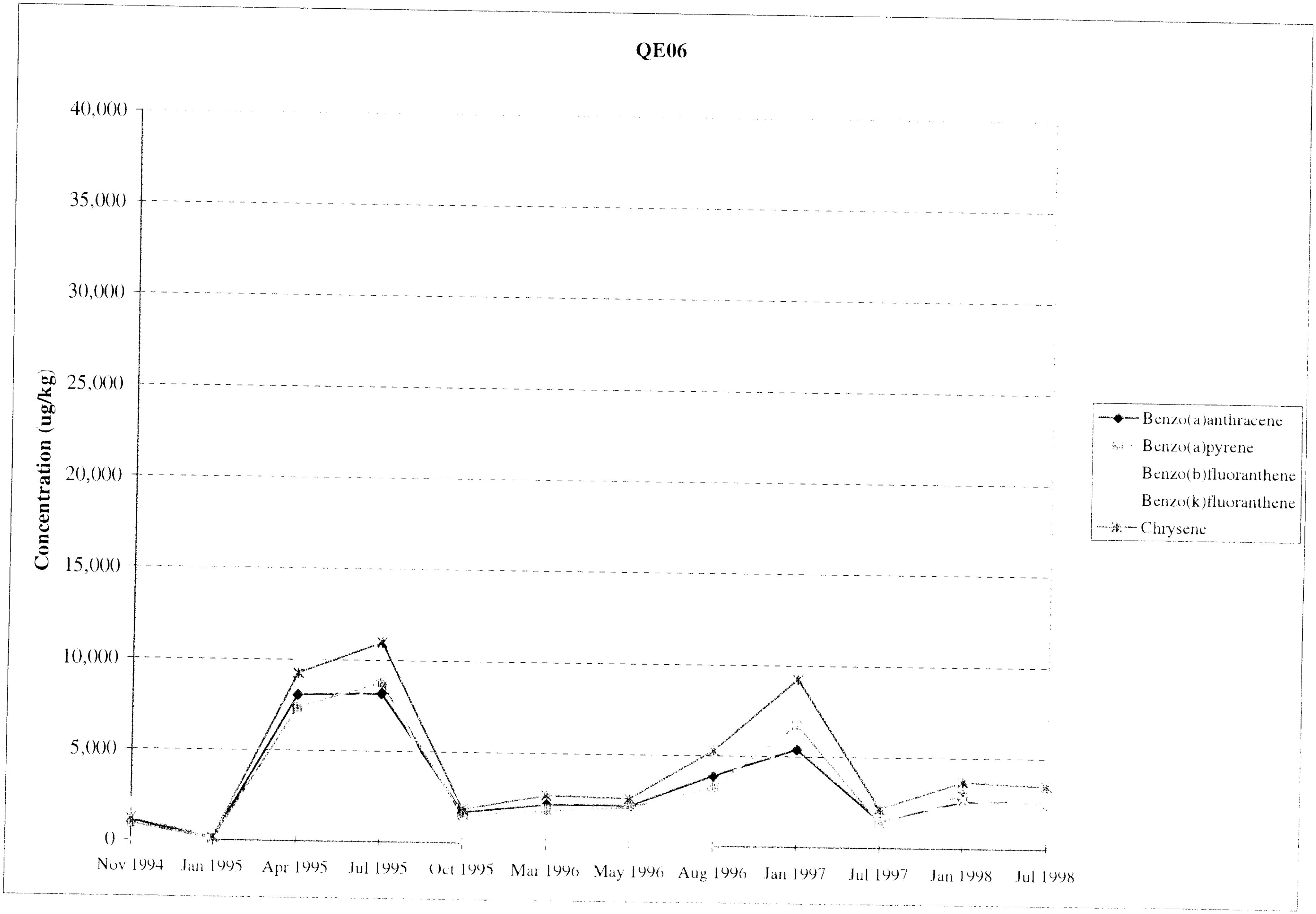


FIGURE 5-2g
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

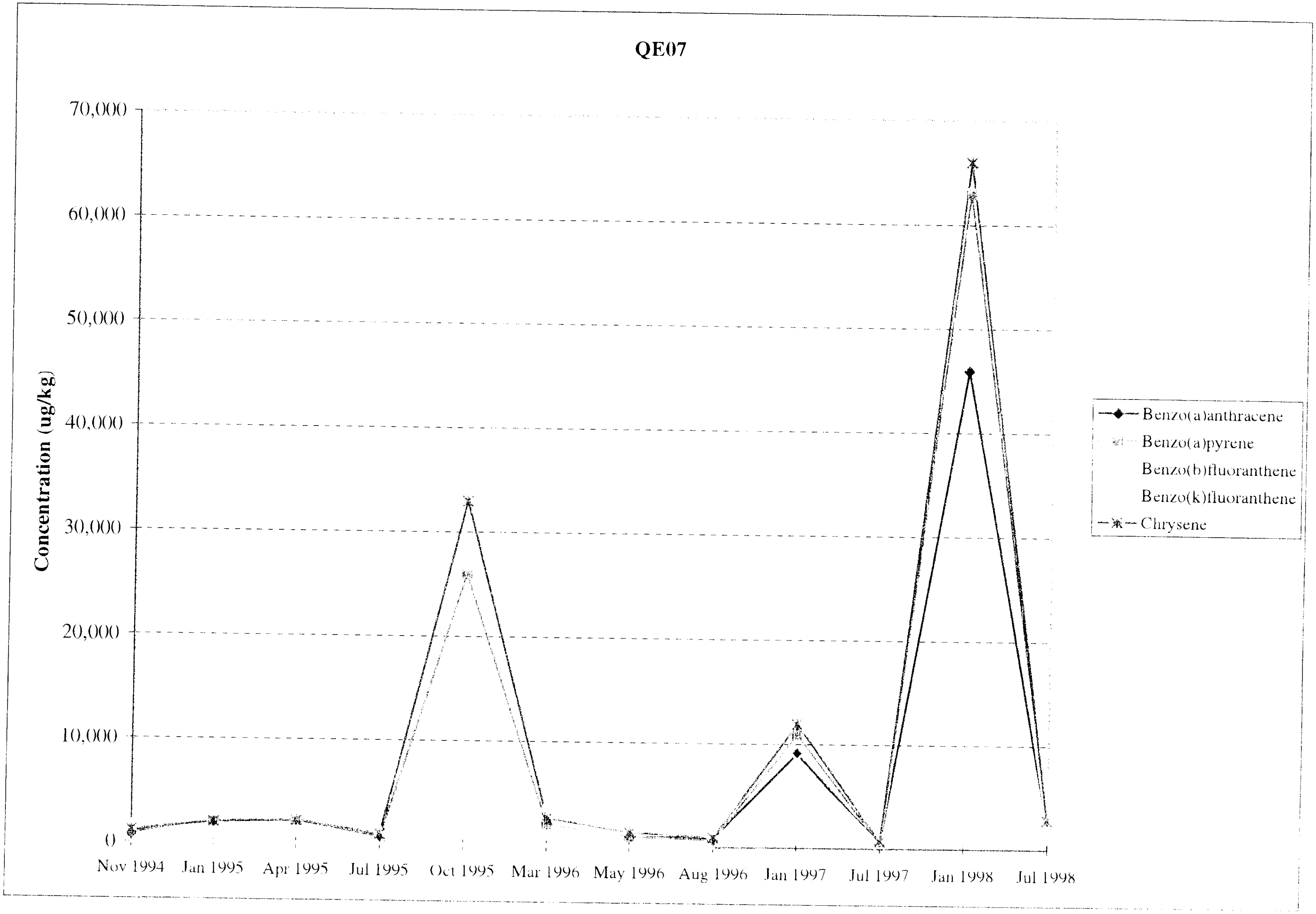


FIGURE 5-2h
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

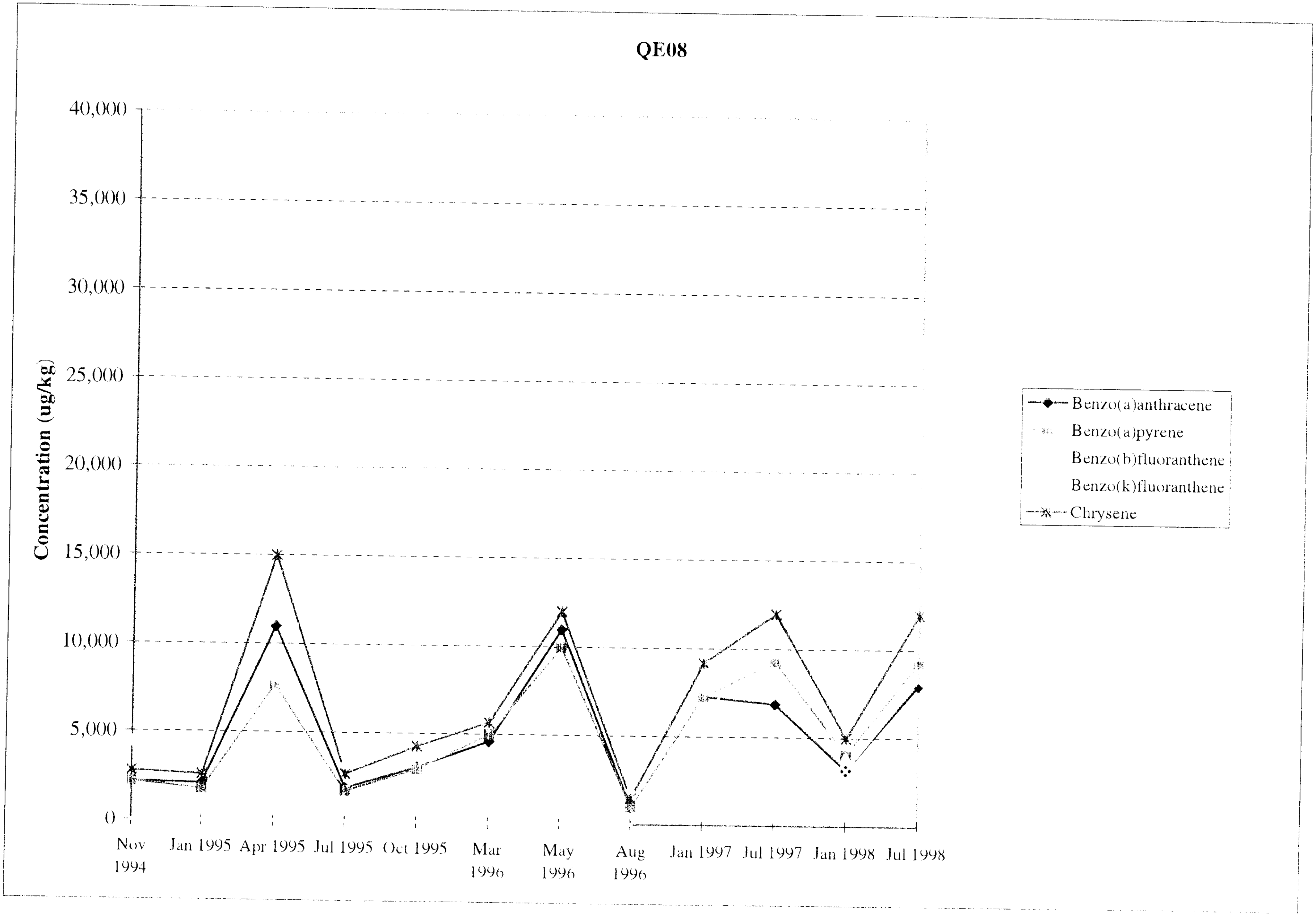


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FIGURE 5-2i

TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

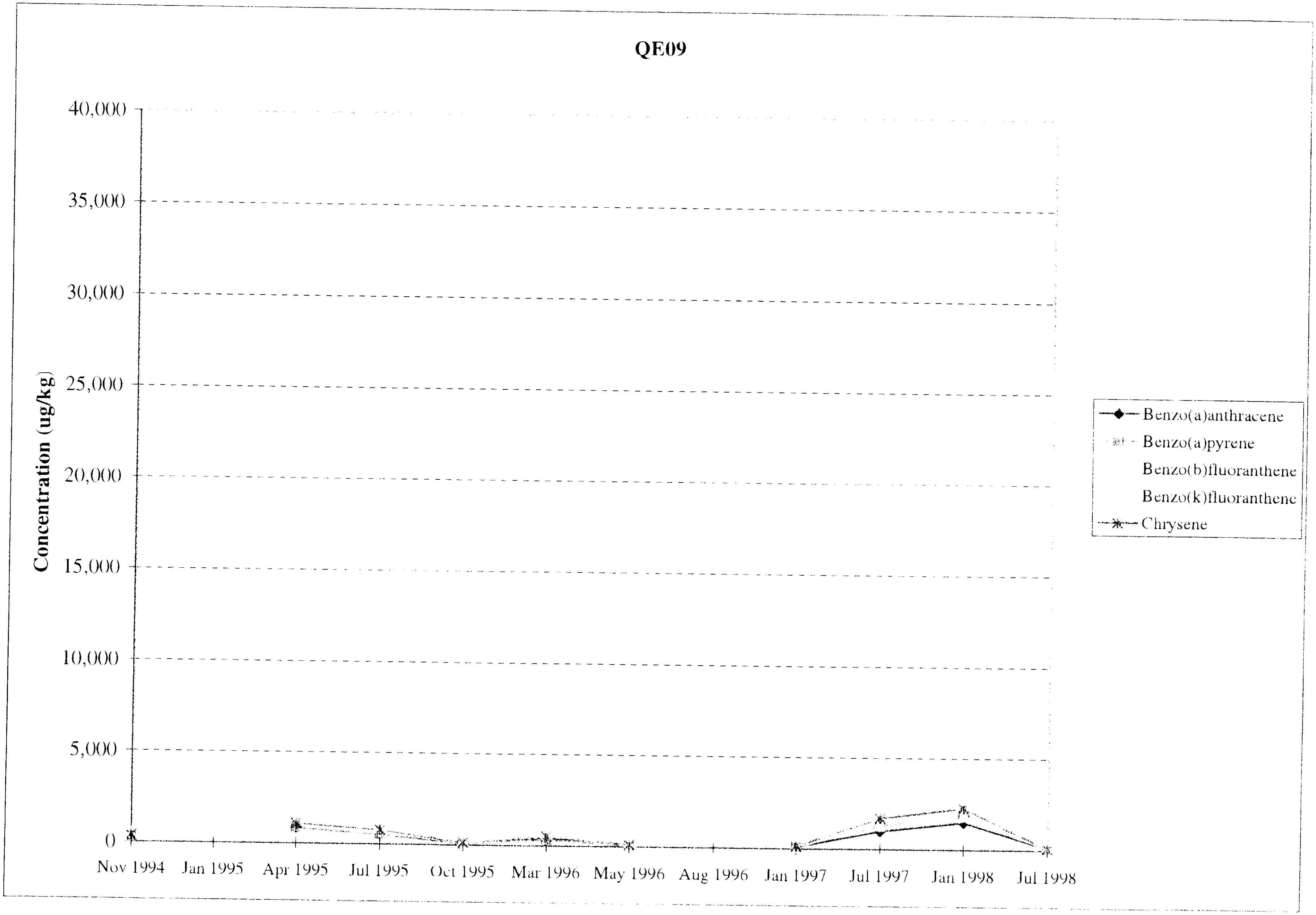

FIGURE 5-2j
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

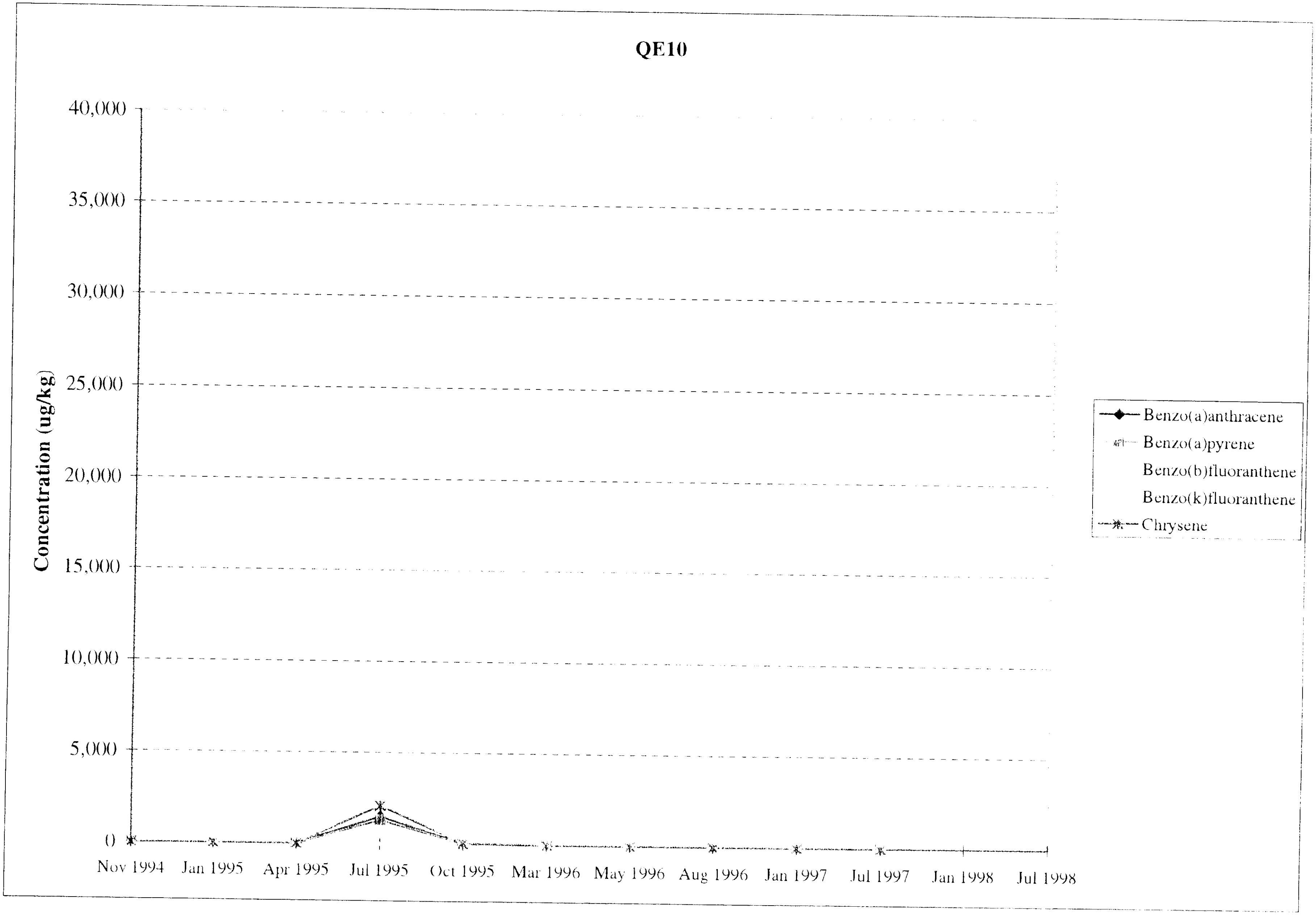

FIGURE 5-2k
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

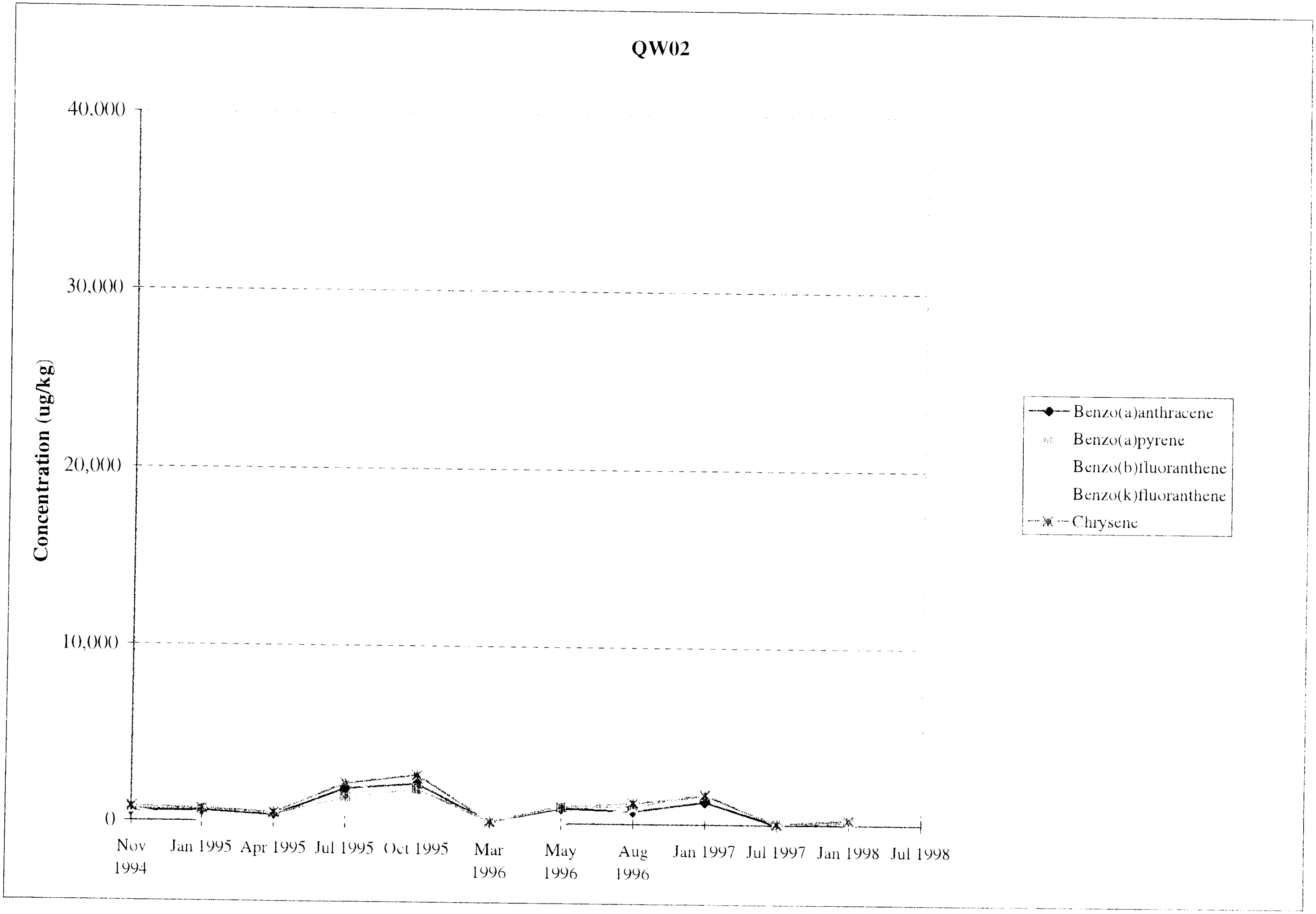

FIGURE 5-21
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

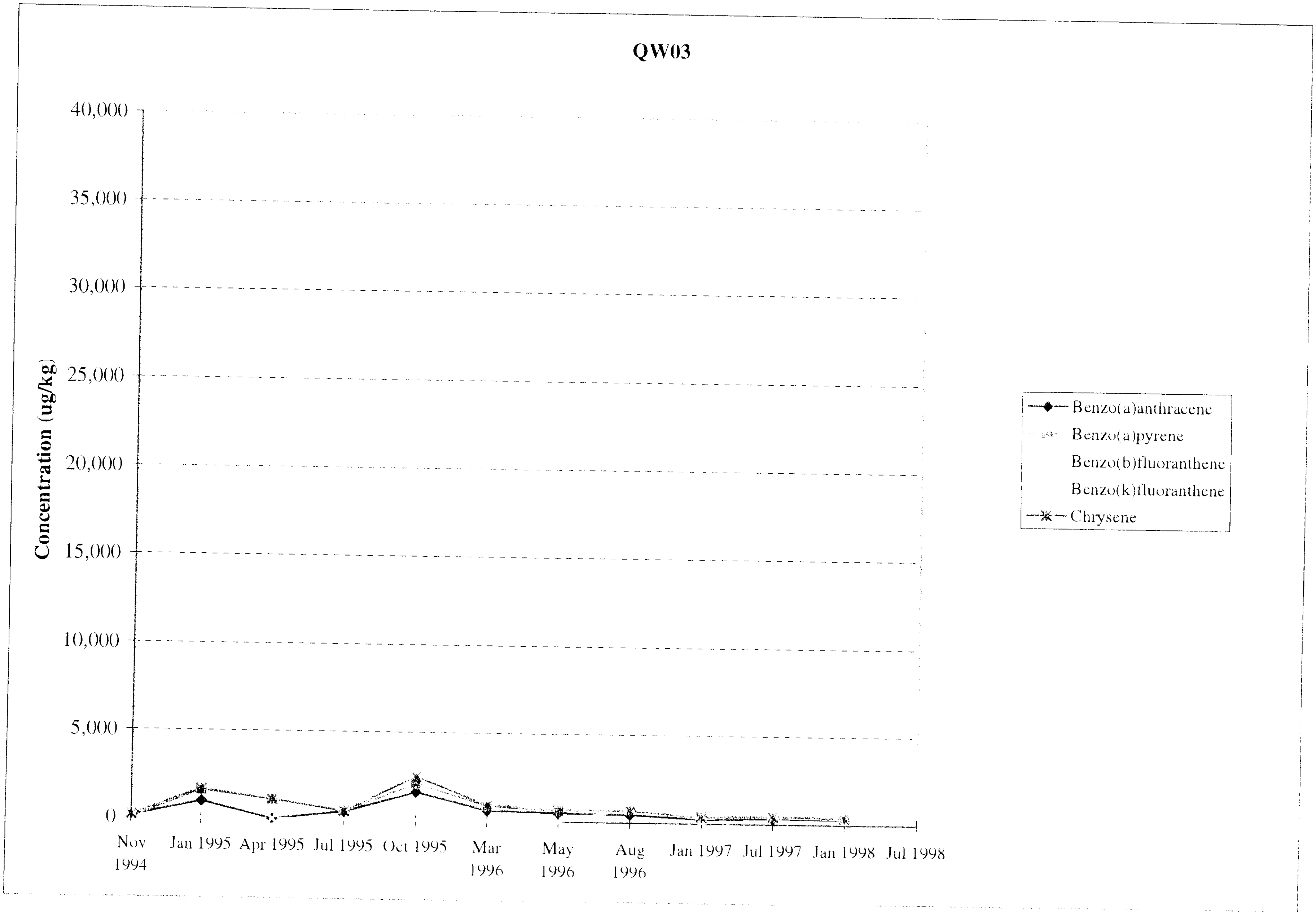

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FIGURE 5-2m

TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

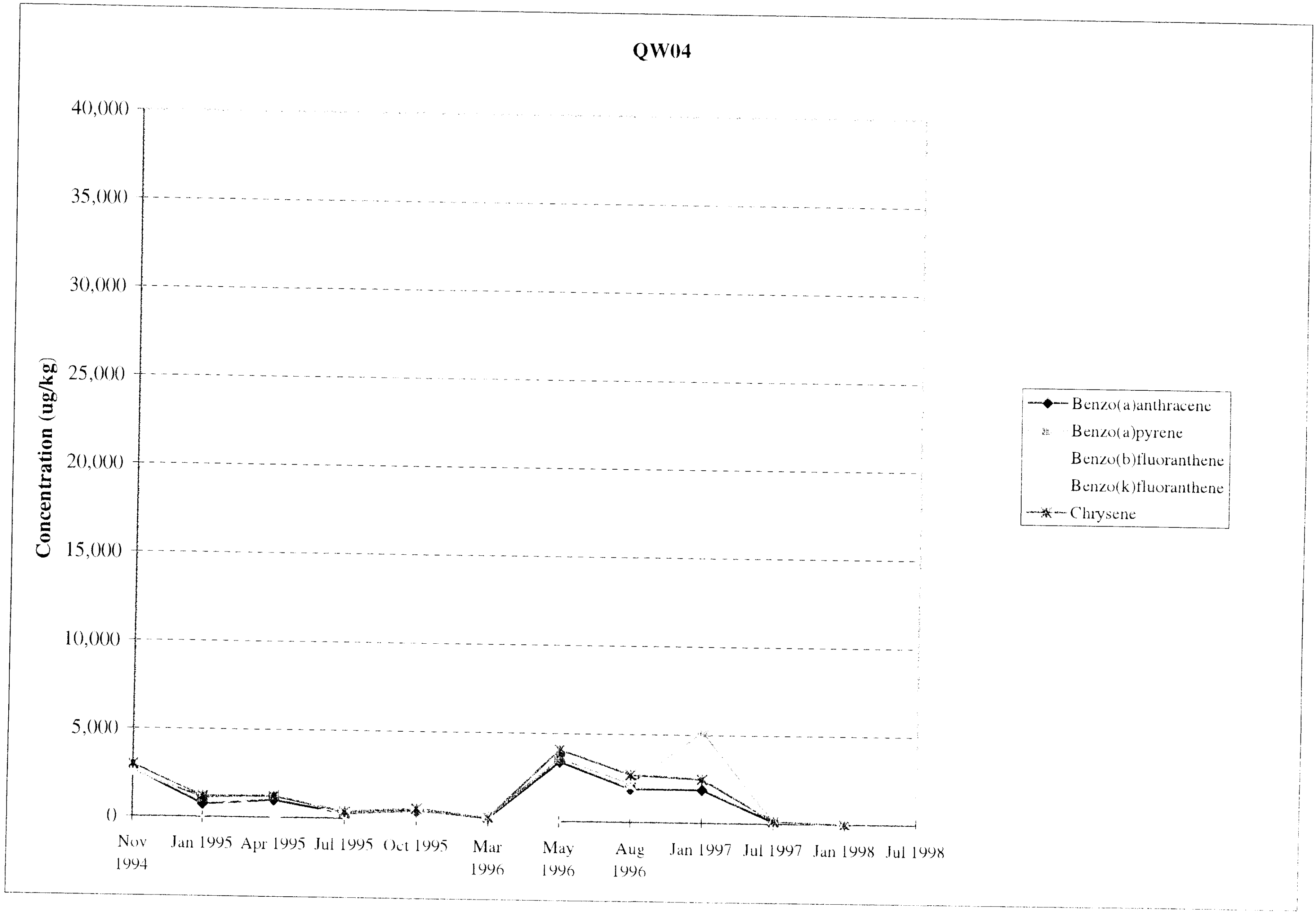

FIGURE 5-2n
TEMPORAL SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

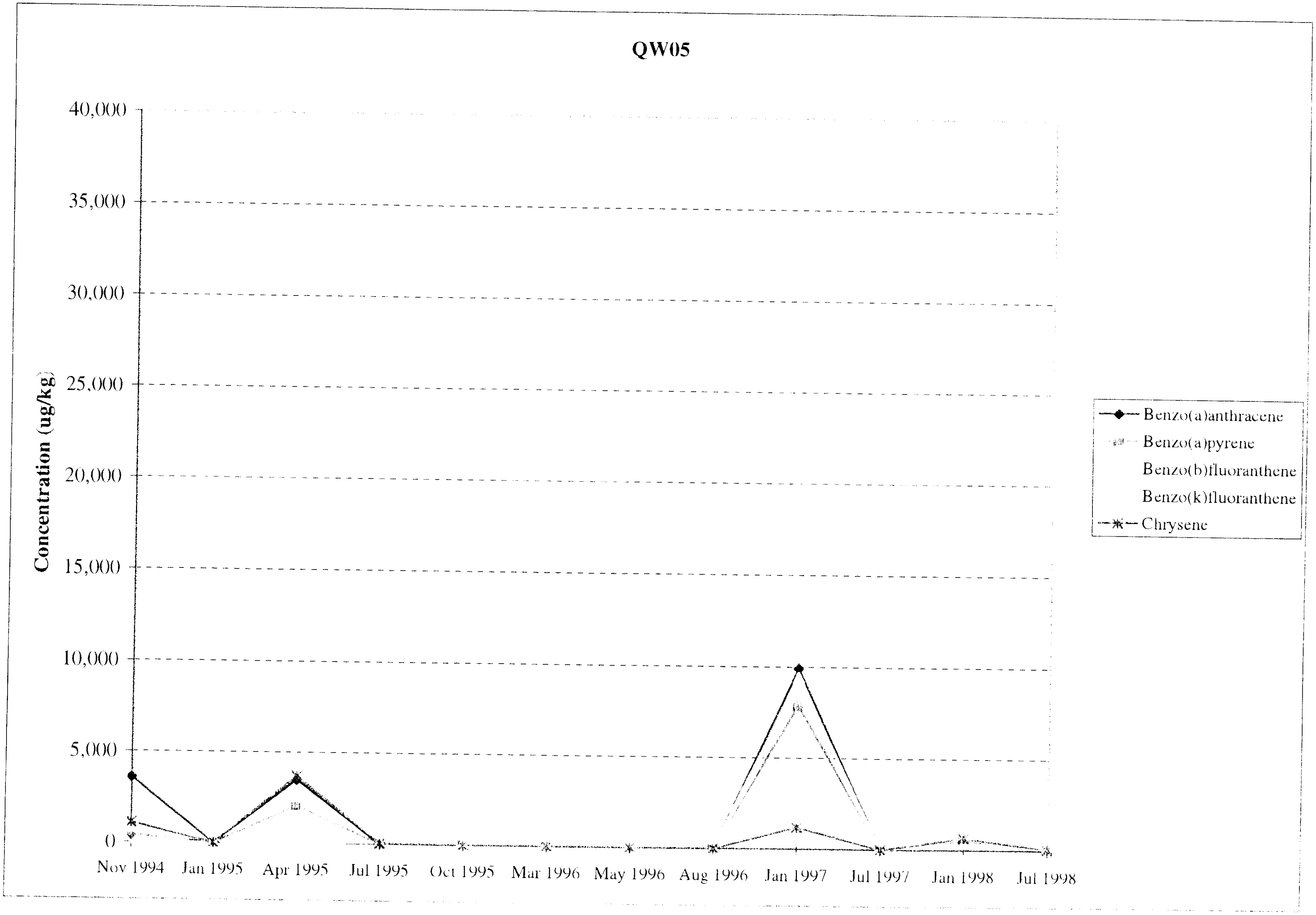

FIGURE 5-3a

EAST SOLIDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

1Qtr1Yr - November 1994

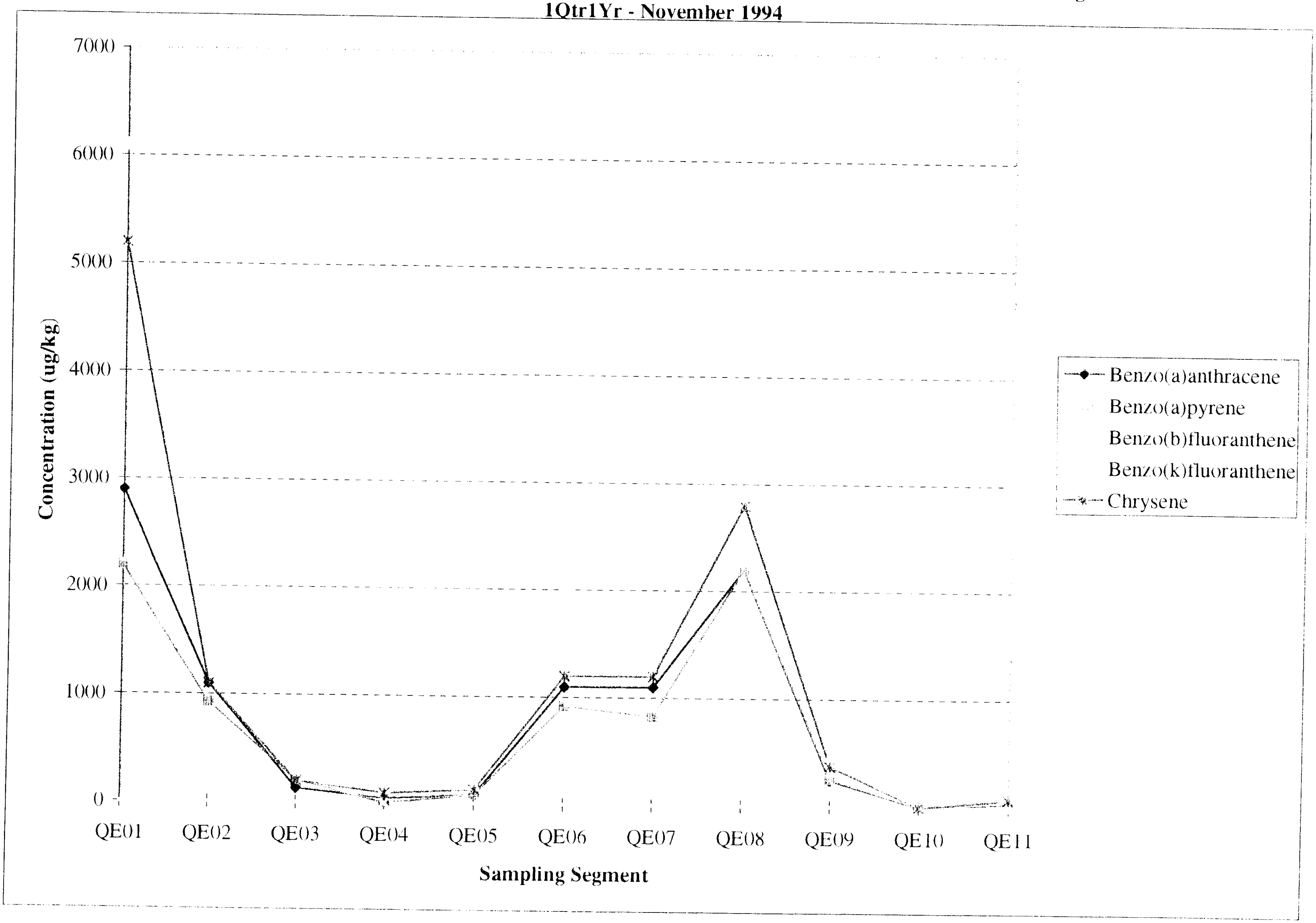

FIGURE 5-3b
EAST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
2Qtr1Yr - January 1995

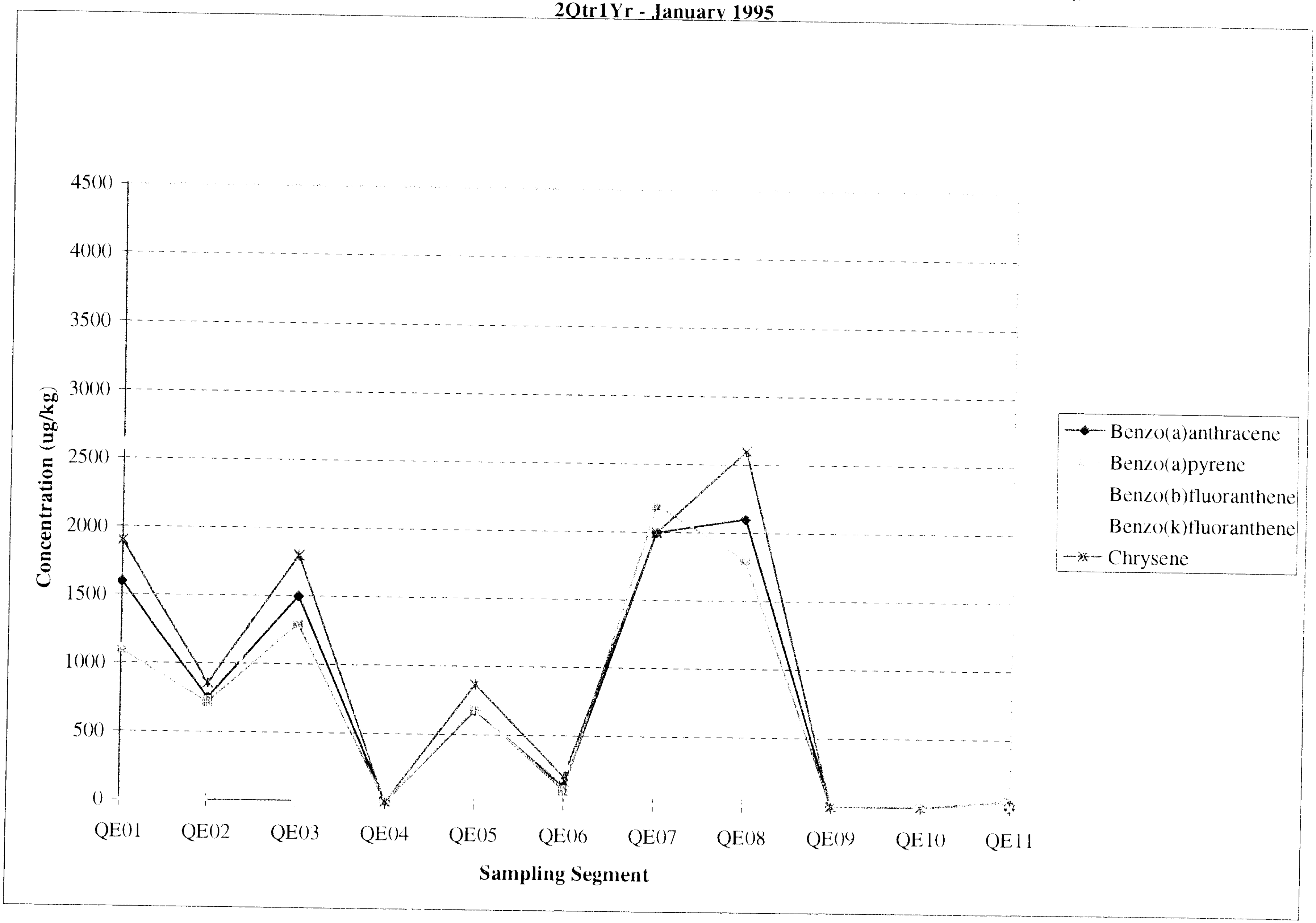

FIGURE 5-3c
EAST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
3Qtr1Yr - April 1995

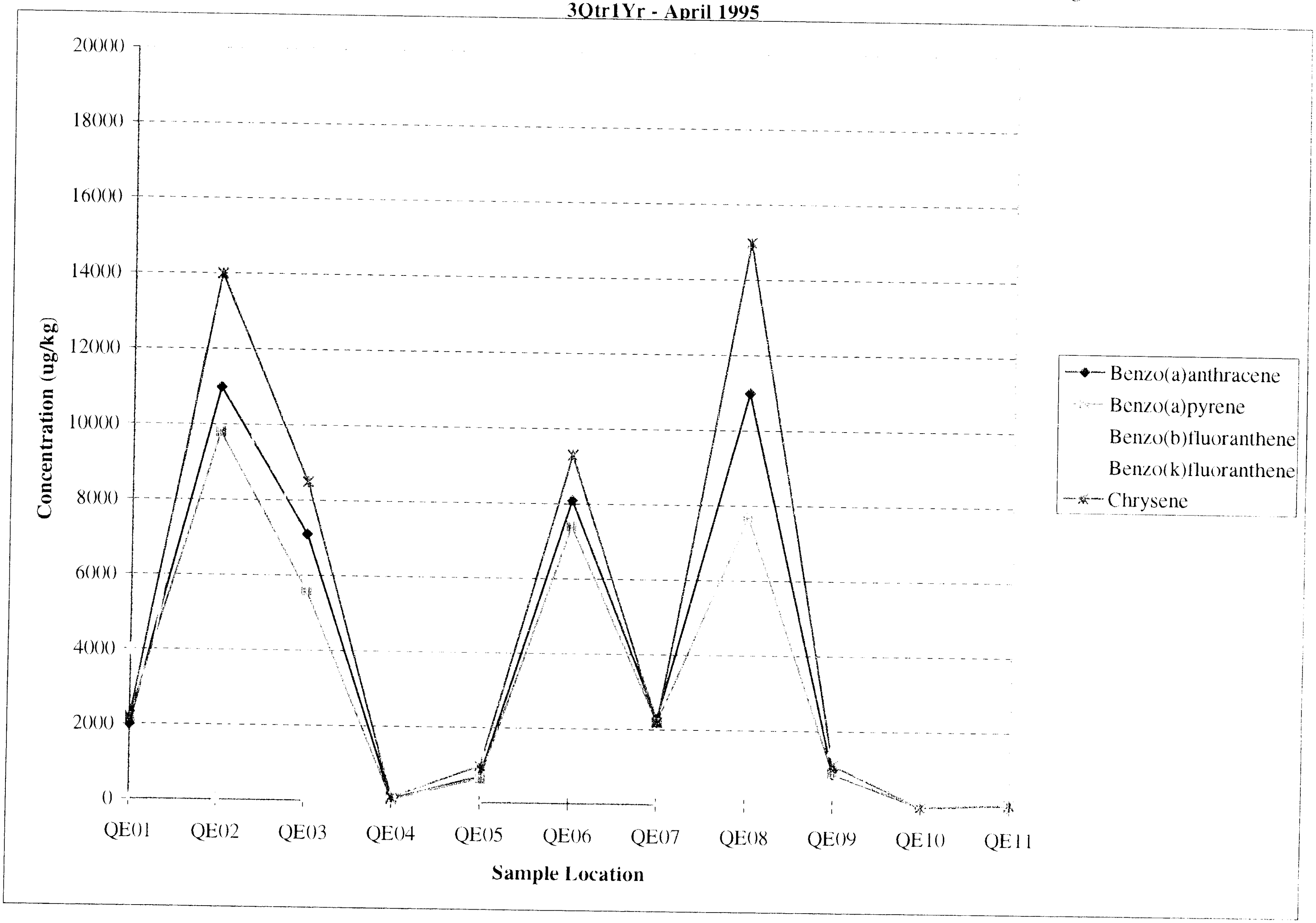

FIGURE 5-3d
EAST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
4Qtr1Yr - July 1995

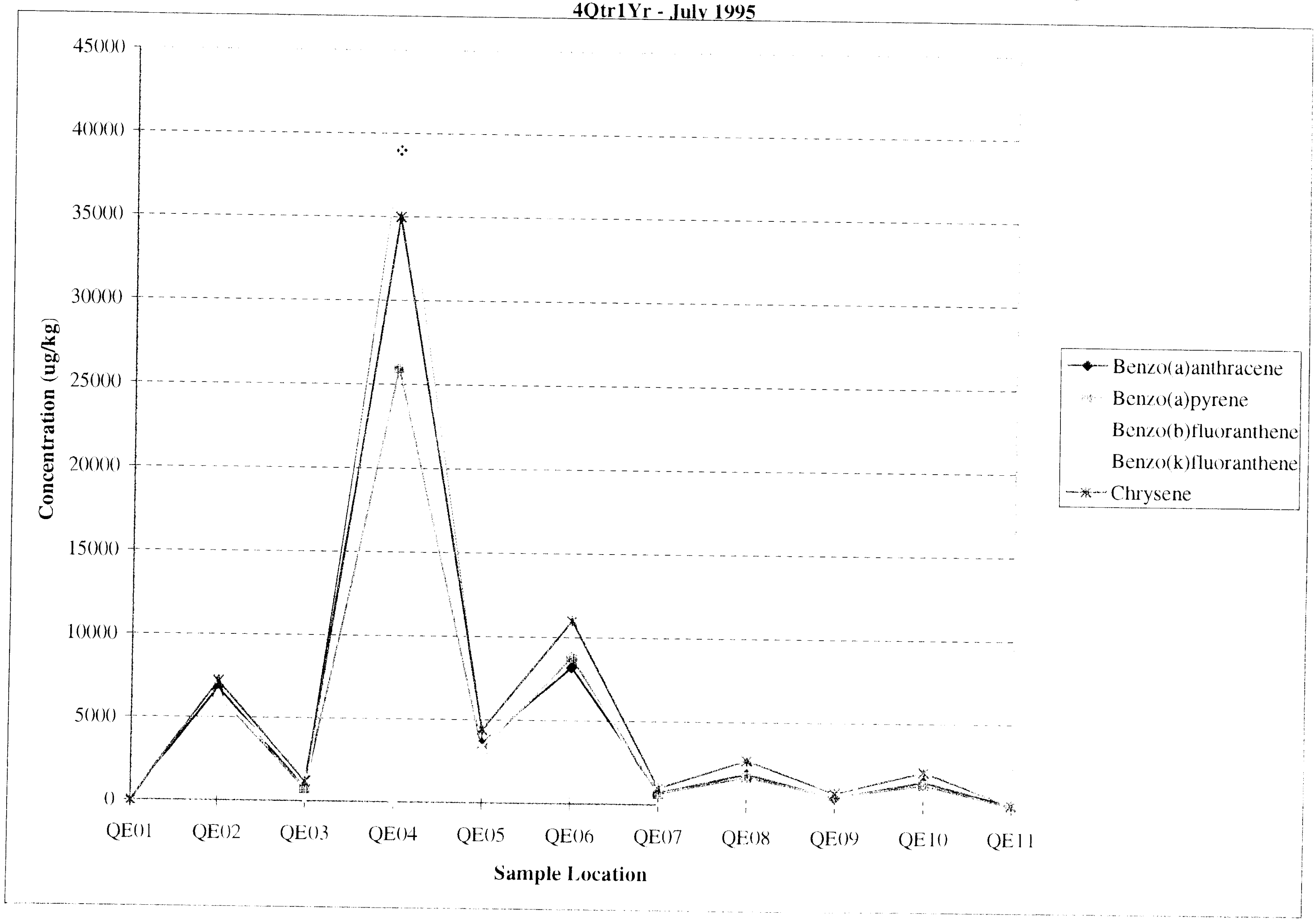

FIGURE 5-3e
EAST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
1Qtr2Yr - October 1995

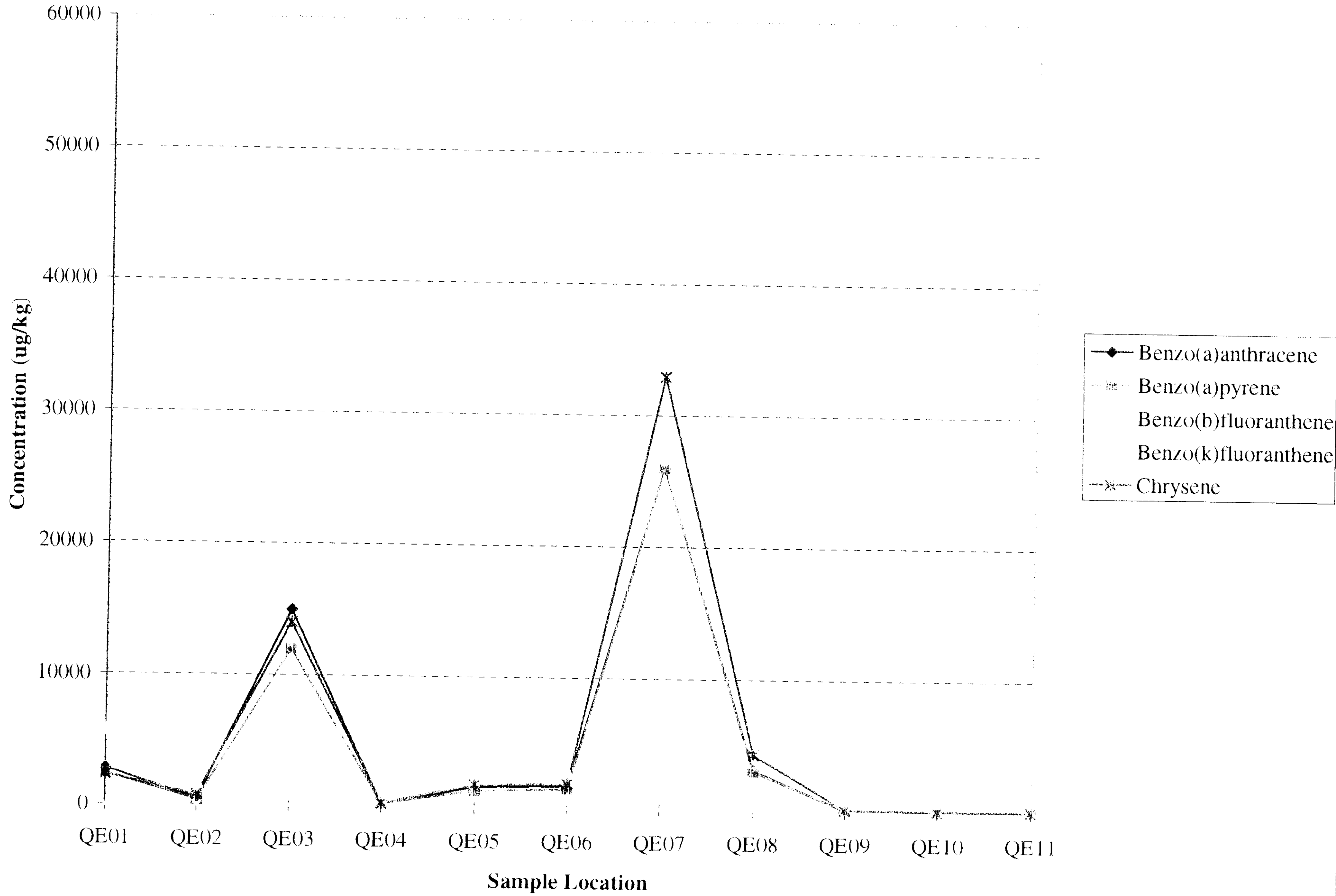

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FIGURE 5-3f
EAST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
2Qtr2Yr - March 1996

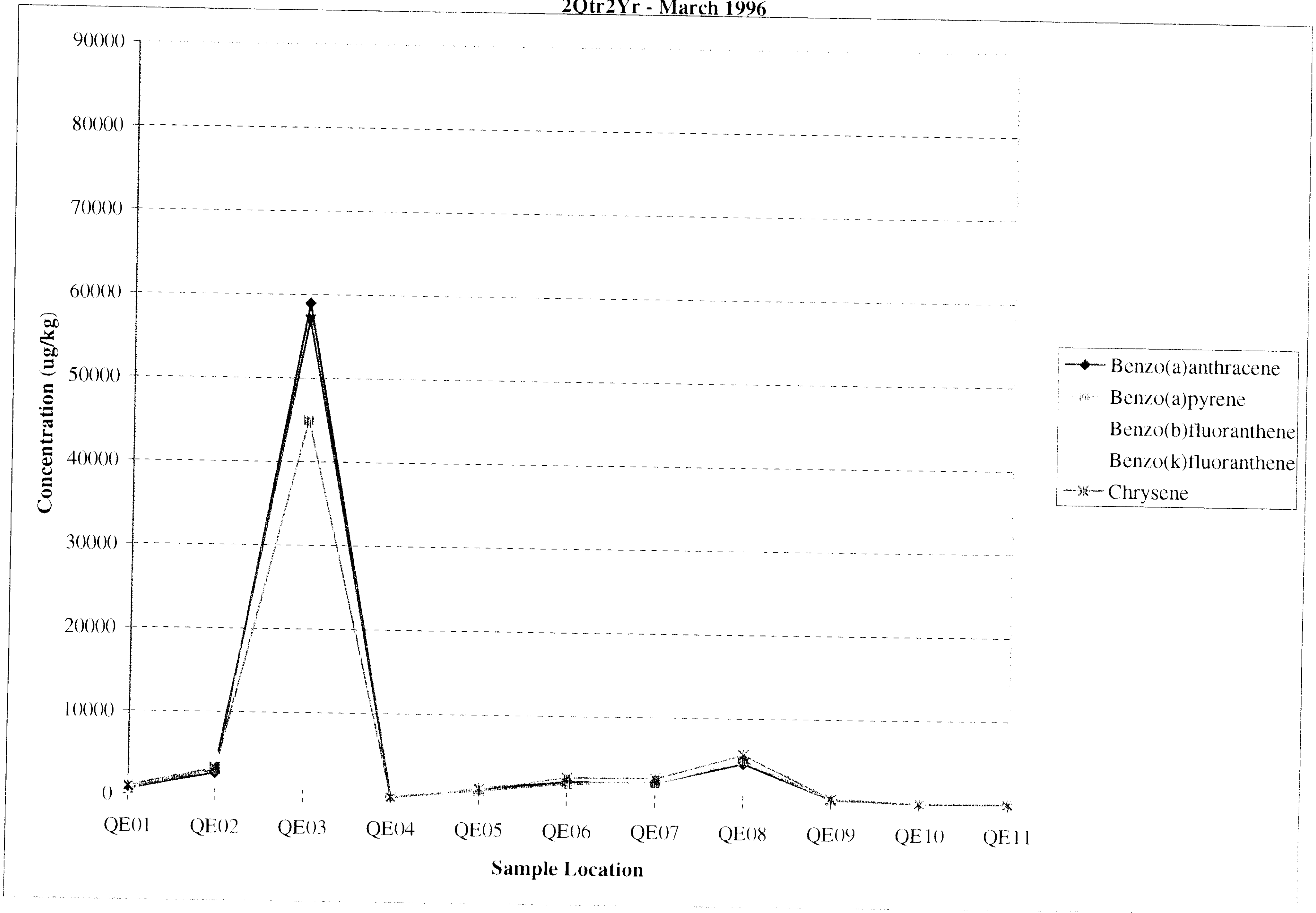

FIGURE 5-3g
EAST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
3Qtr2Yr - May 1996

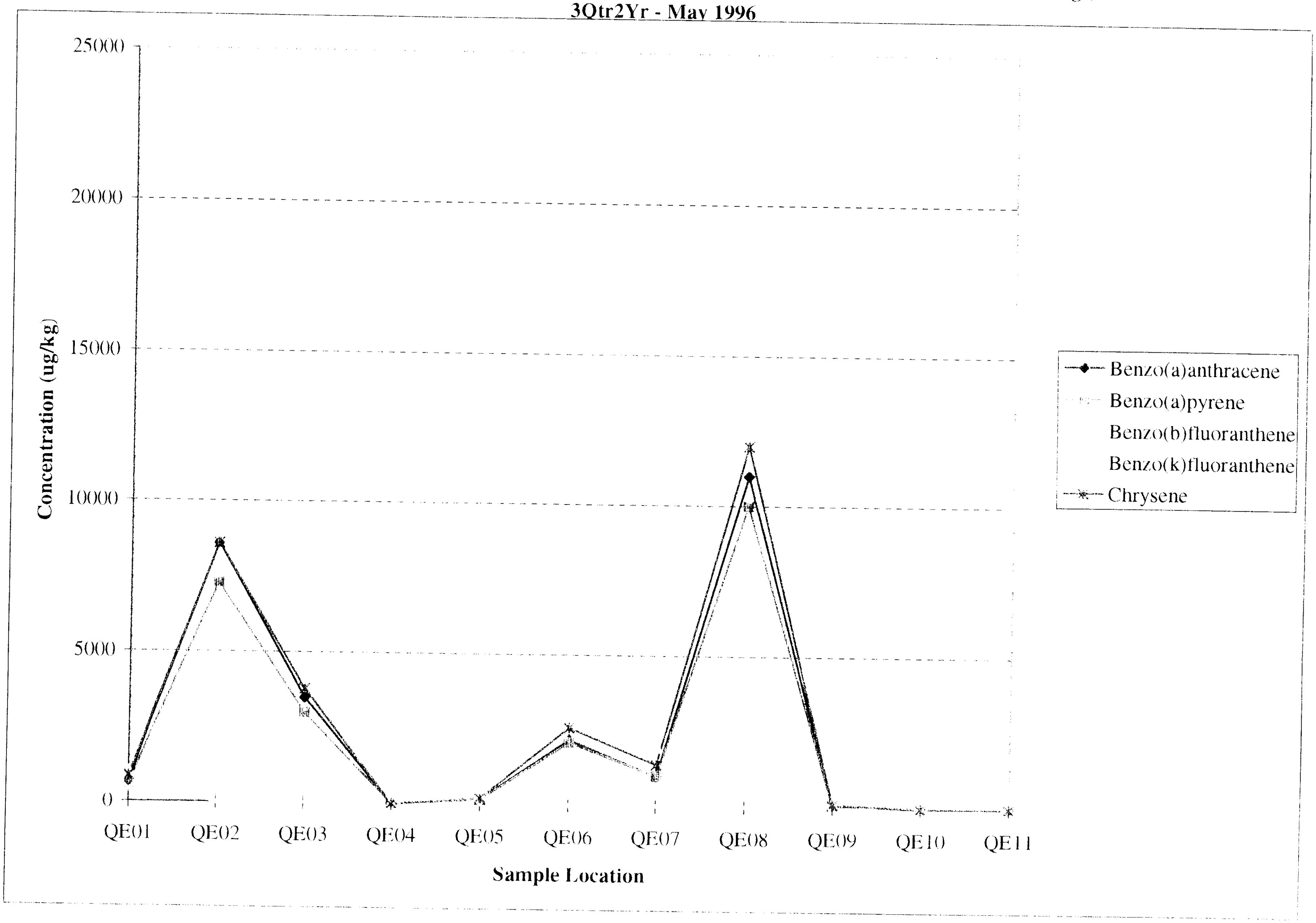

FIGURE 5-3h
EAST SOLDIERCREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
4Qtr2Yr - August 1996

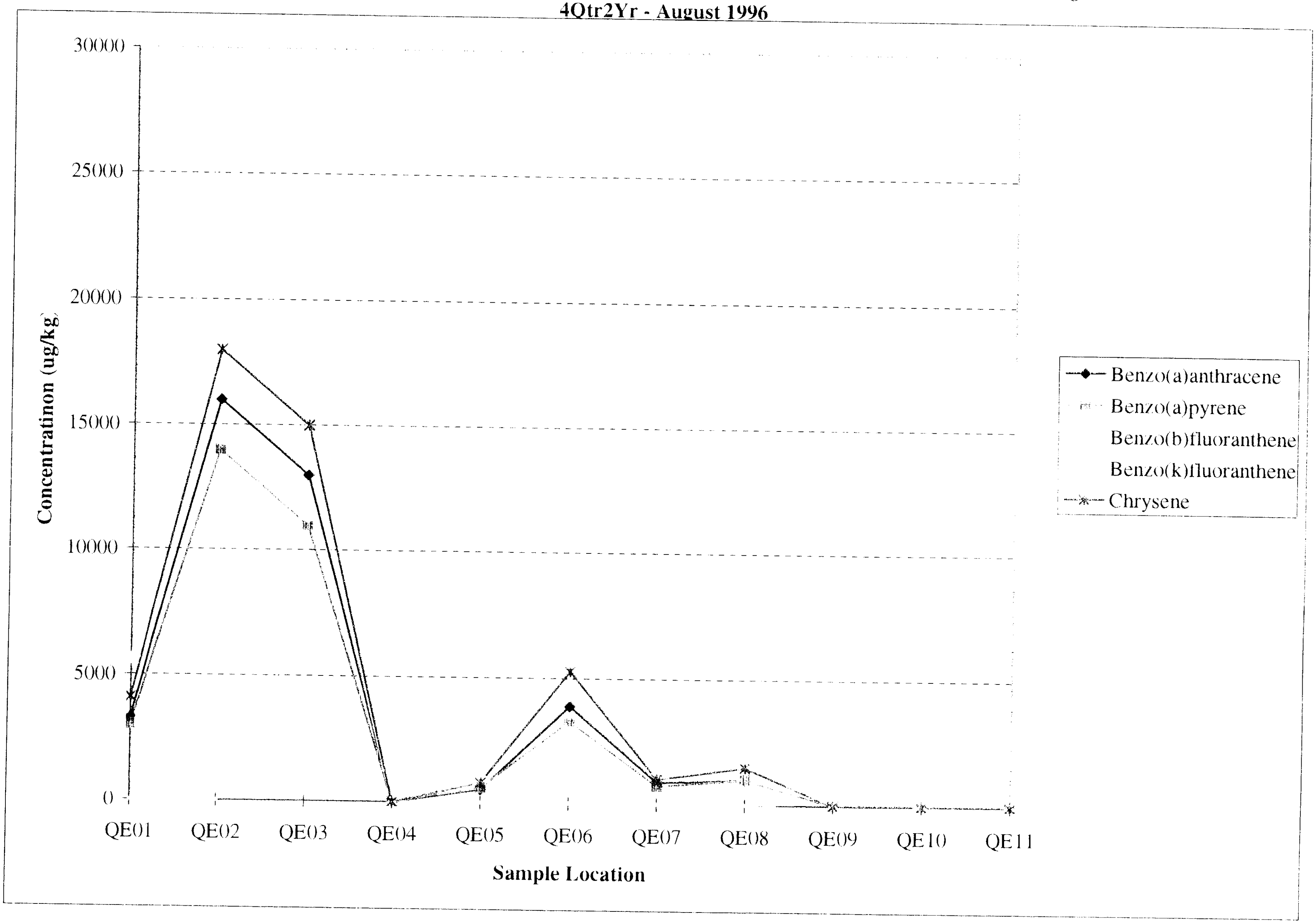

FIGURE 5-3i
EAST SOLDIERCREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
1Evnt3Yr - January 1997

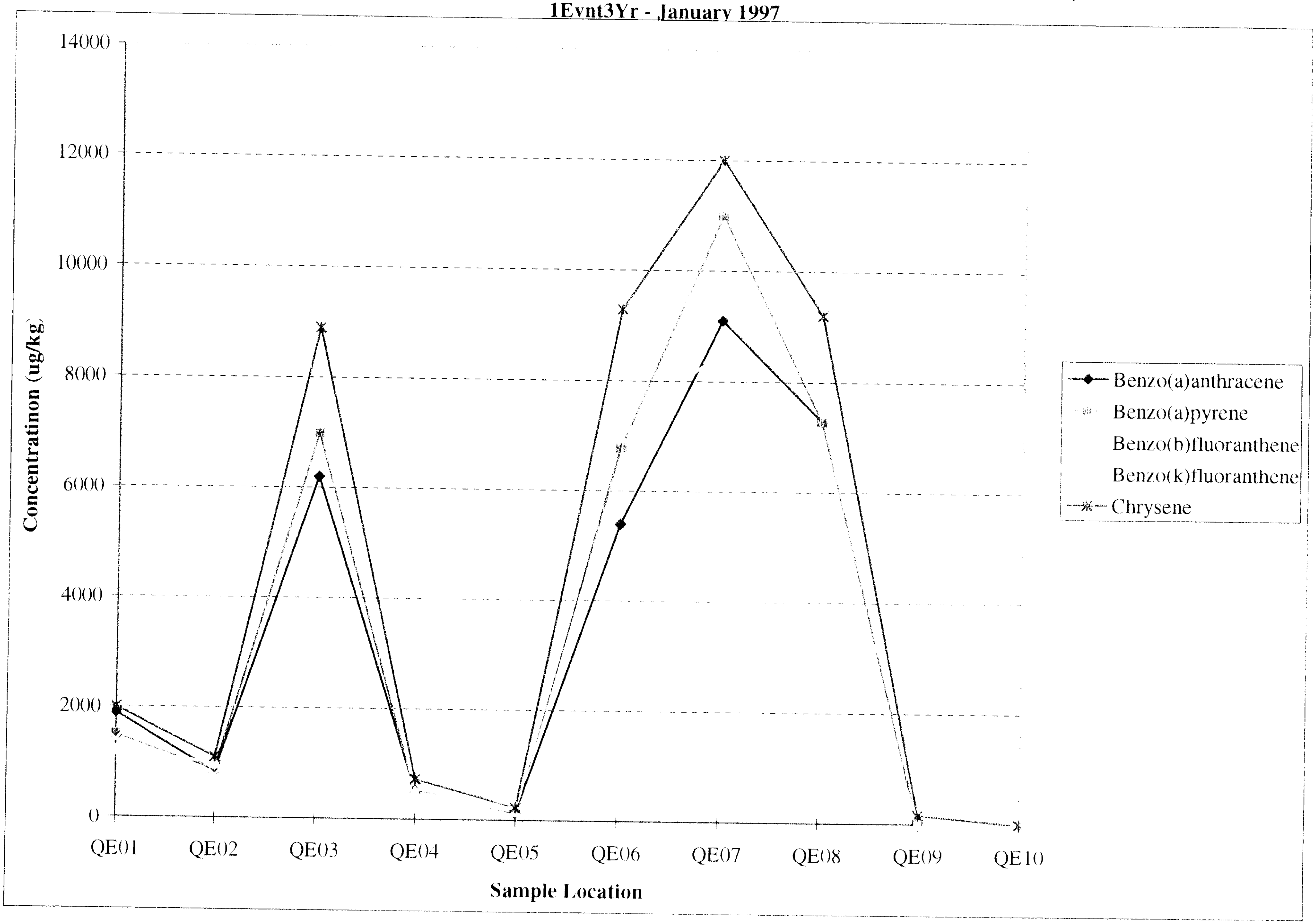

FIGURE 5-3j

EAST SOLDIERCREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

2Evnt3Yr - July 1997

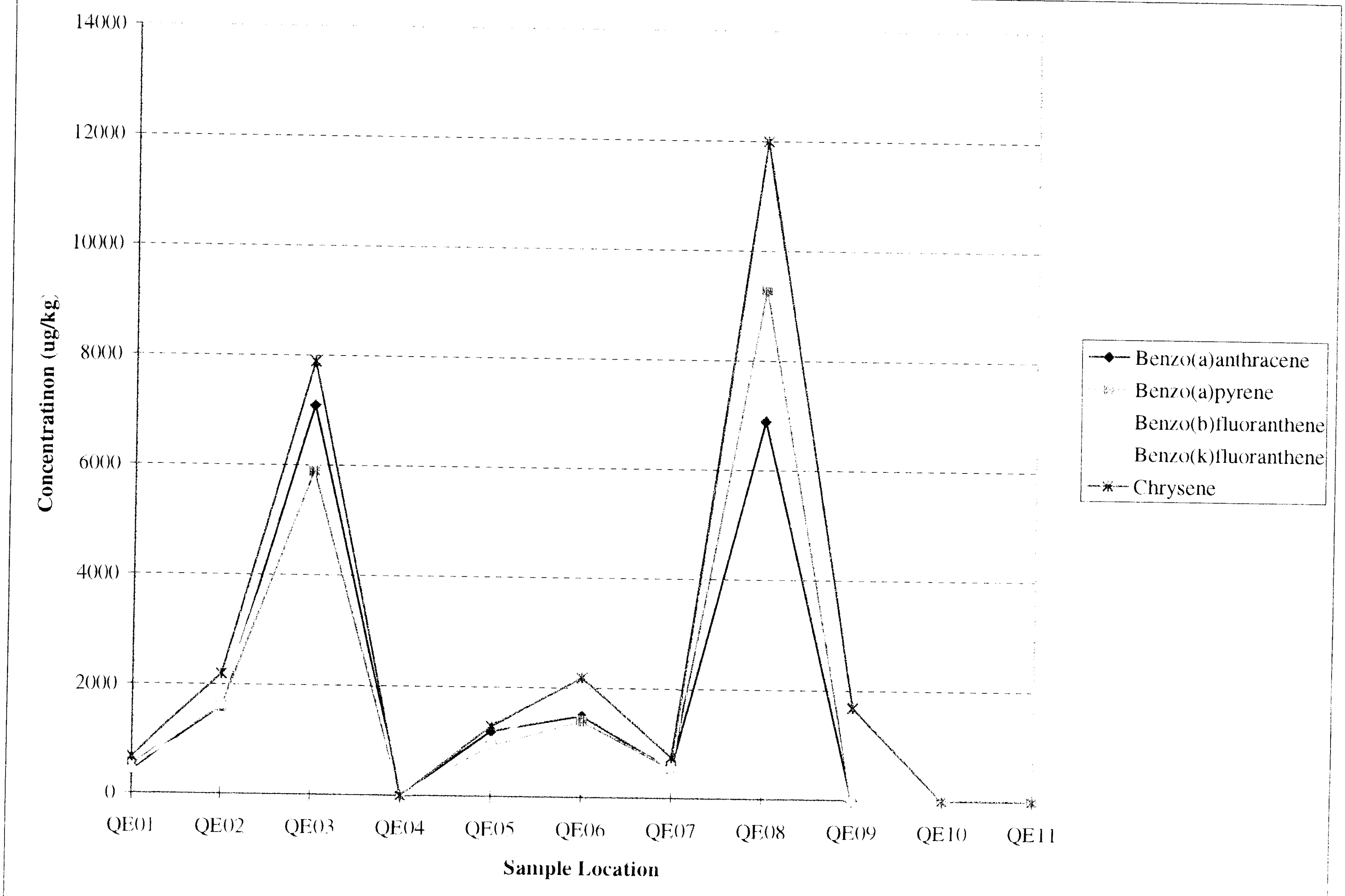

FIGURE 5-3k
EAST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
1Evnt4Yr - January 1998

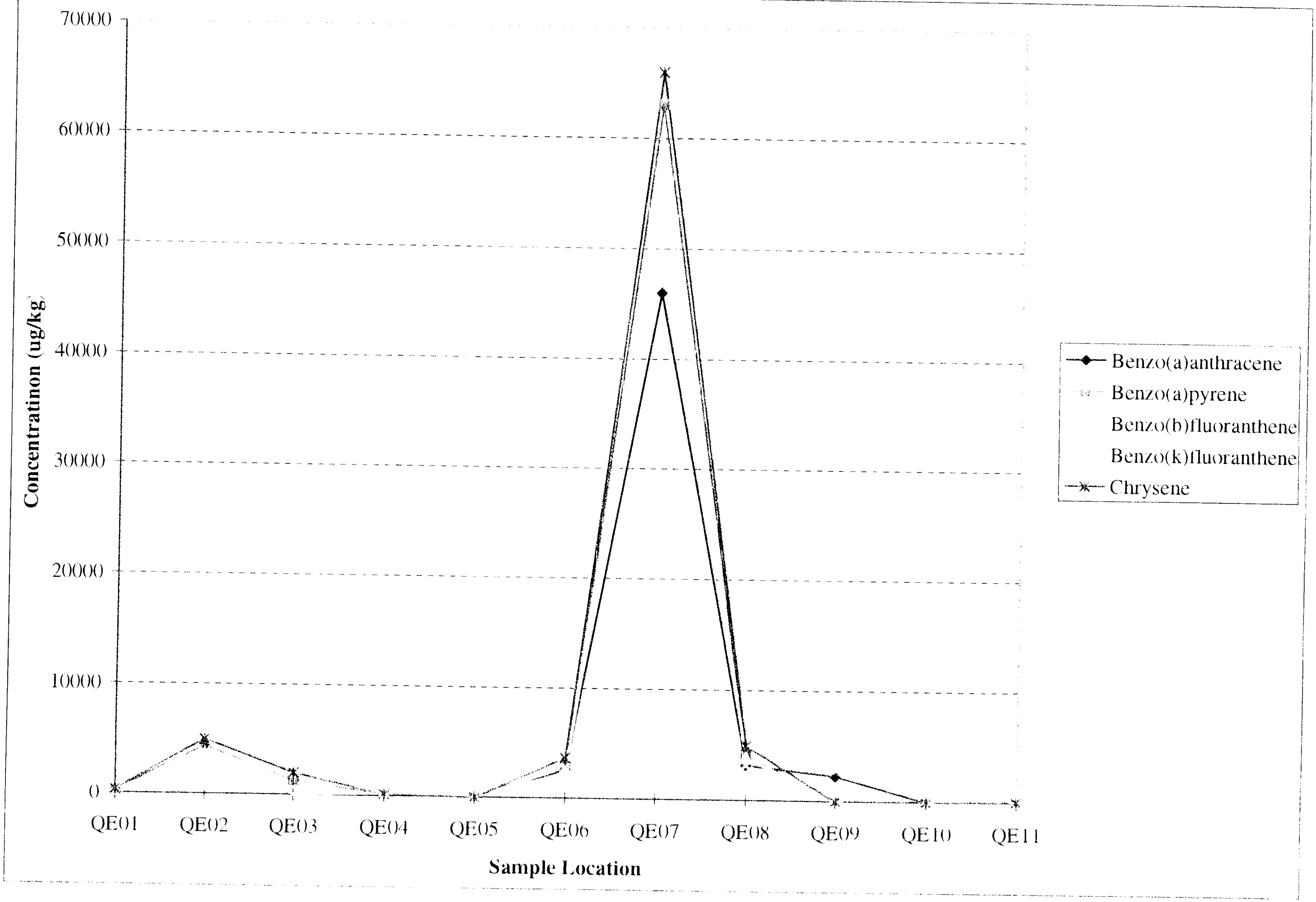

FIGURE 5-31

EAST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

2Evnt4Yr - July 1998

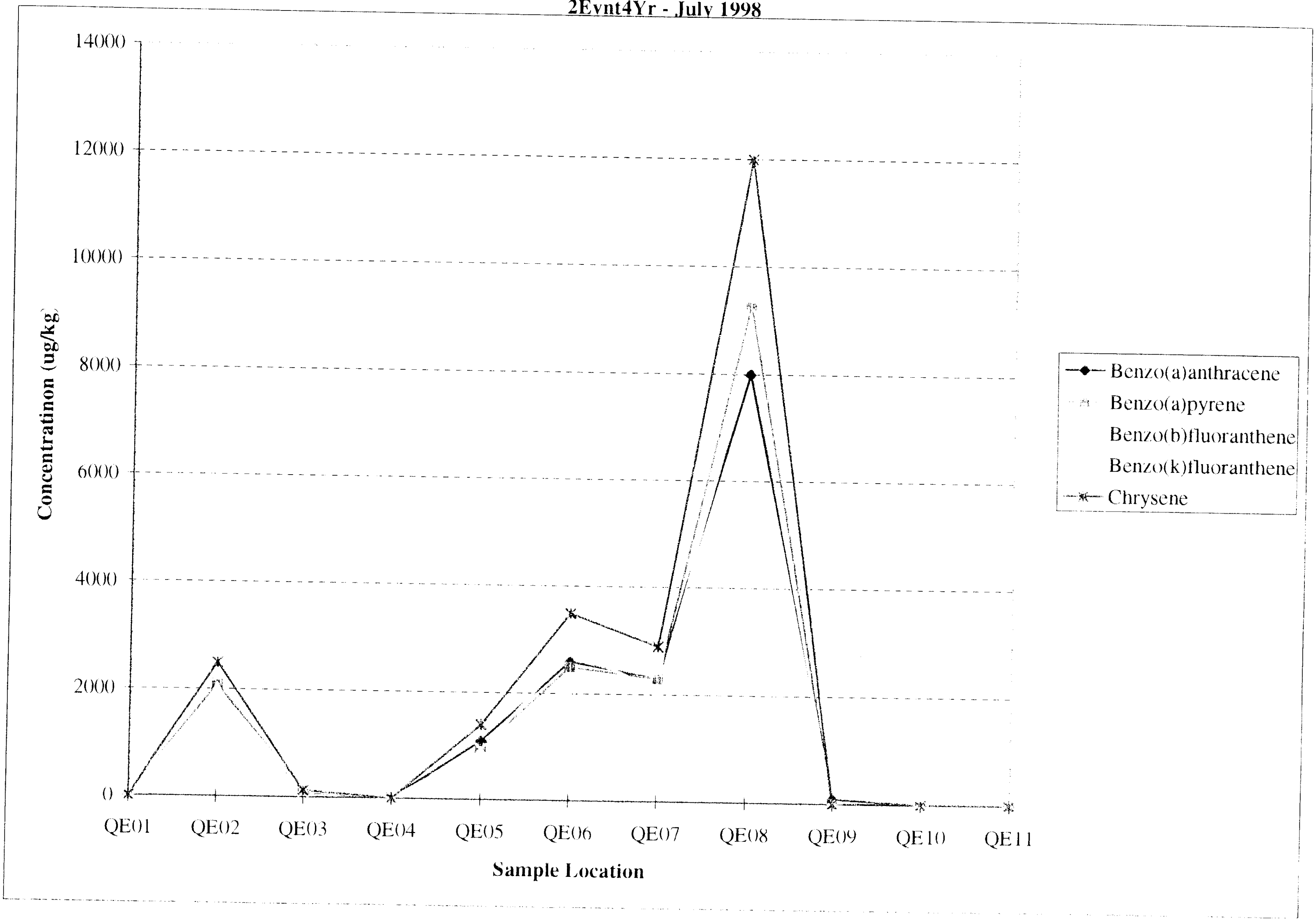

FIGURE 5-4a
WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
1Qtr1Yr - November 1994

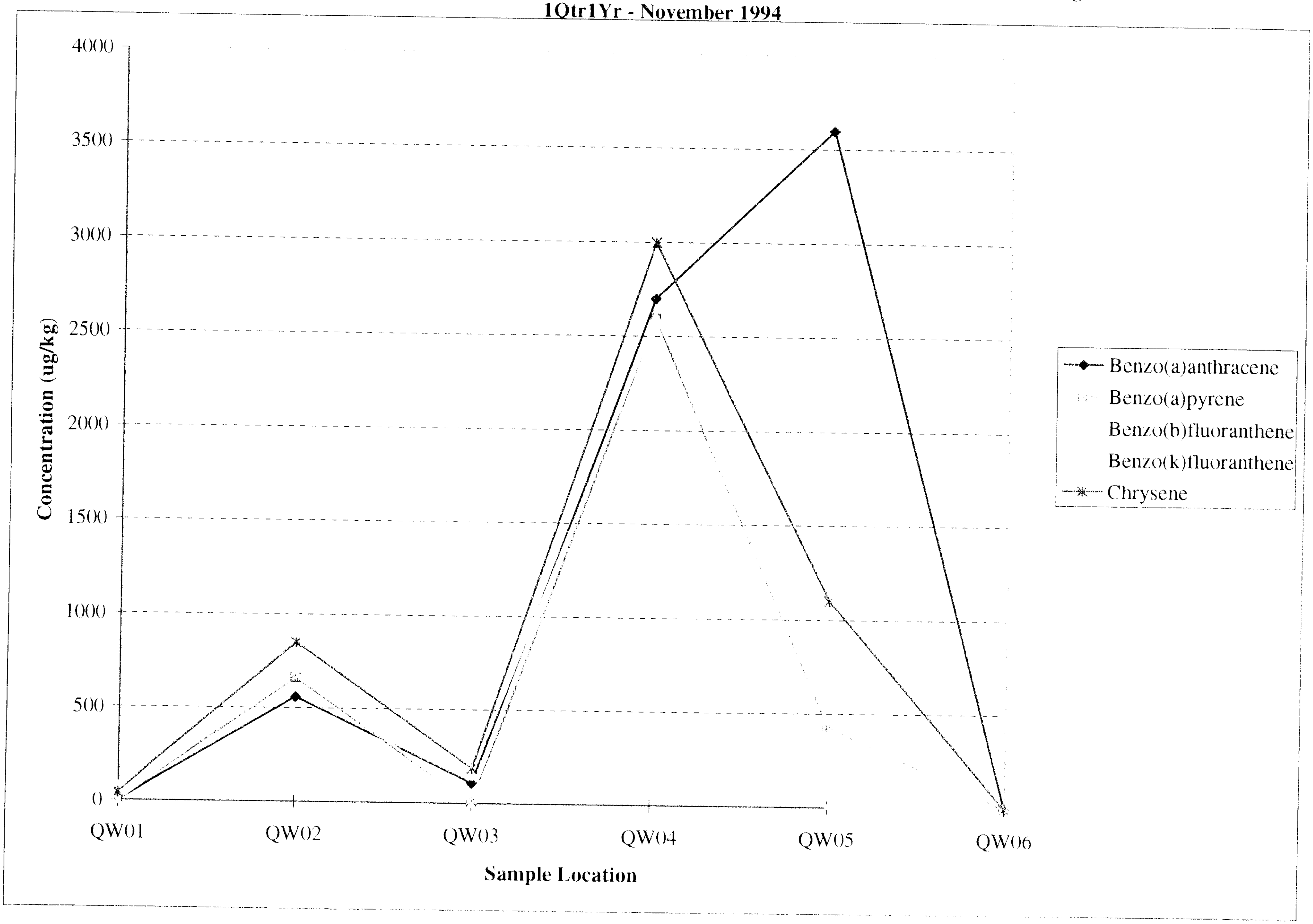

FIGURE 5-4b
WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
2Qtr1Yr - January 1995

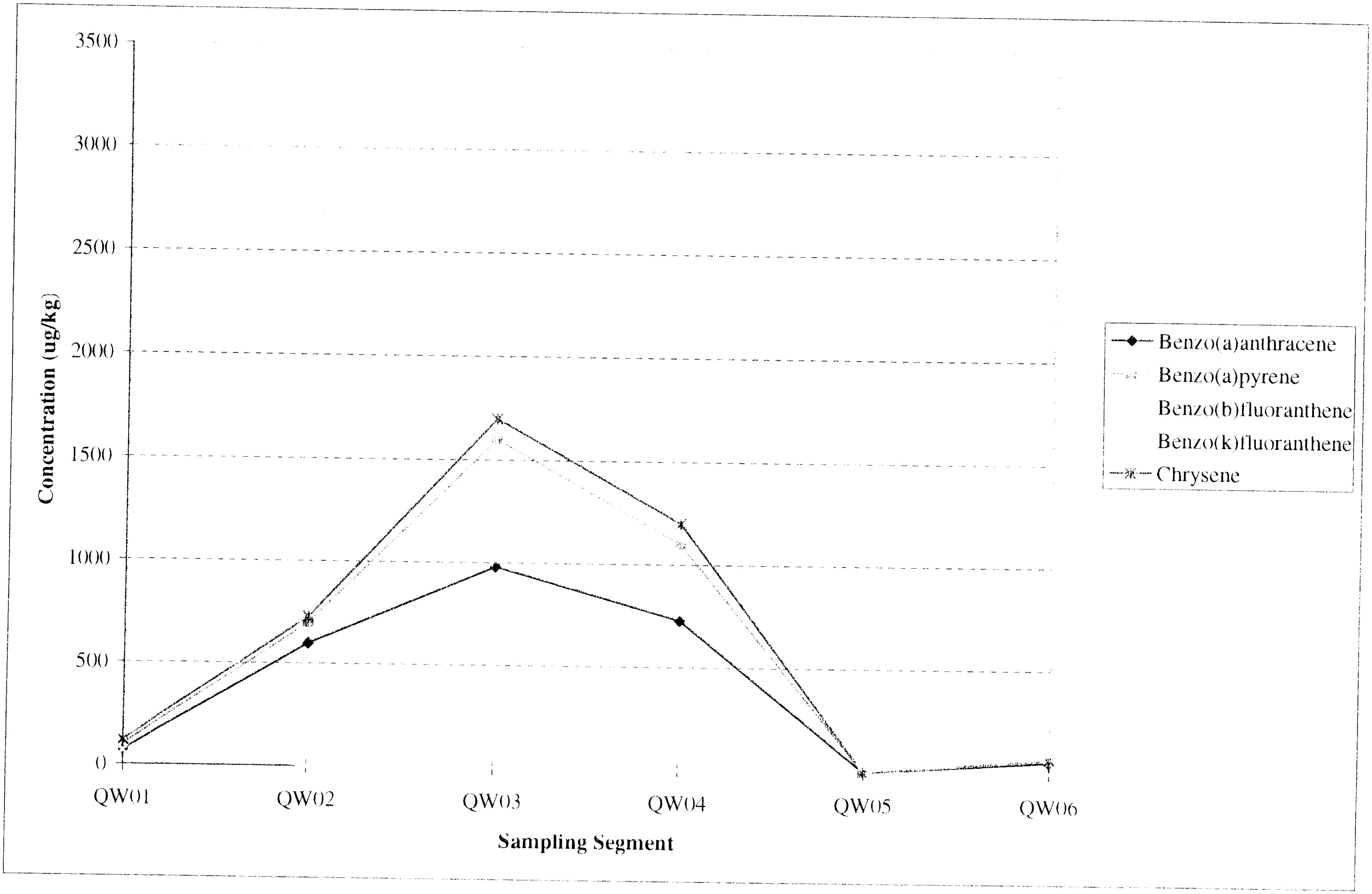

FIGURE 5-4c
WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
3Qtr1Yr - April 1995

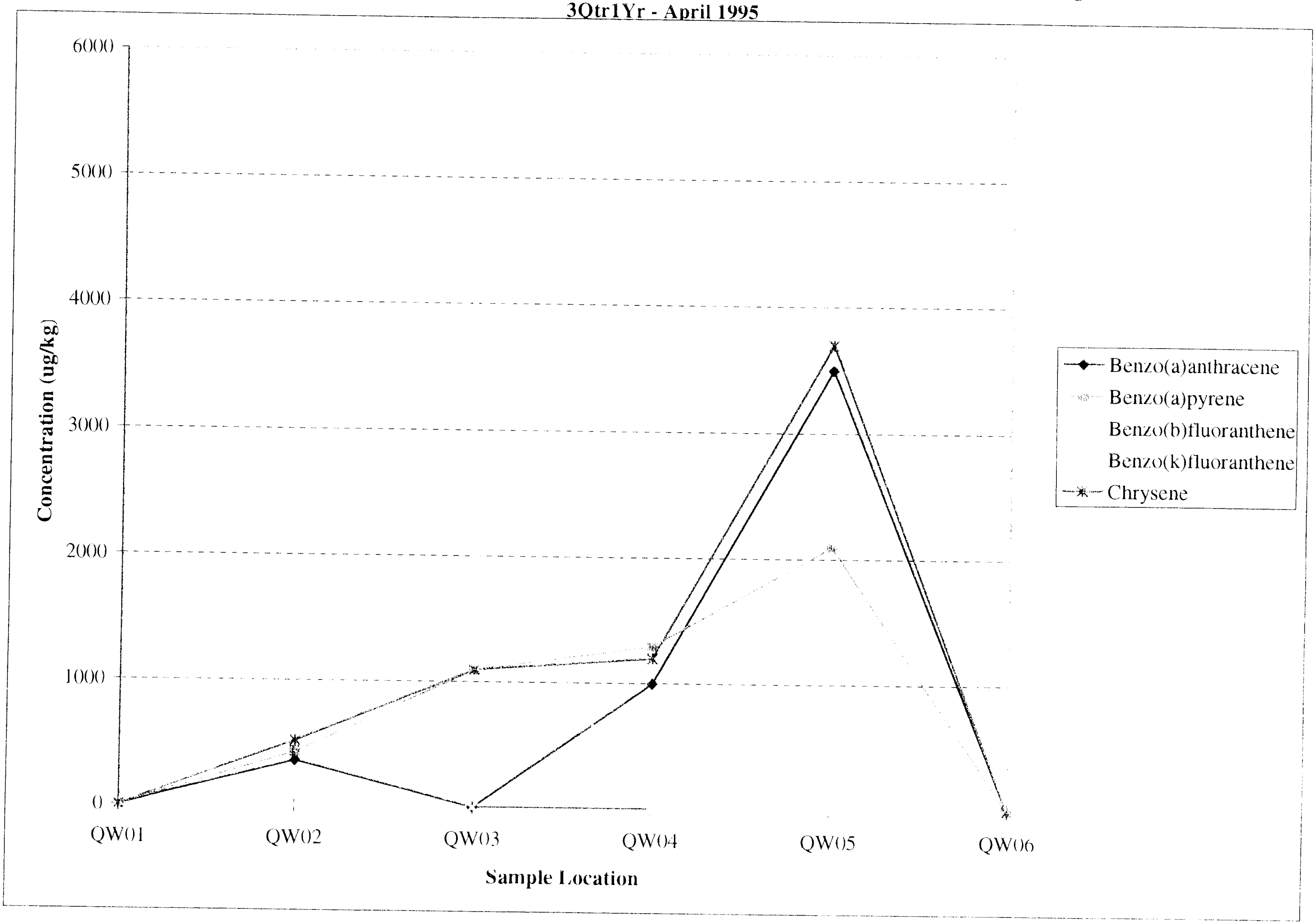

FIGURE 5-4d
WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
4Qtr1Yr - July 1995

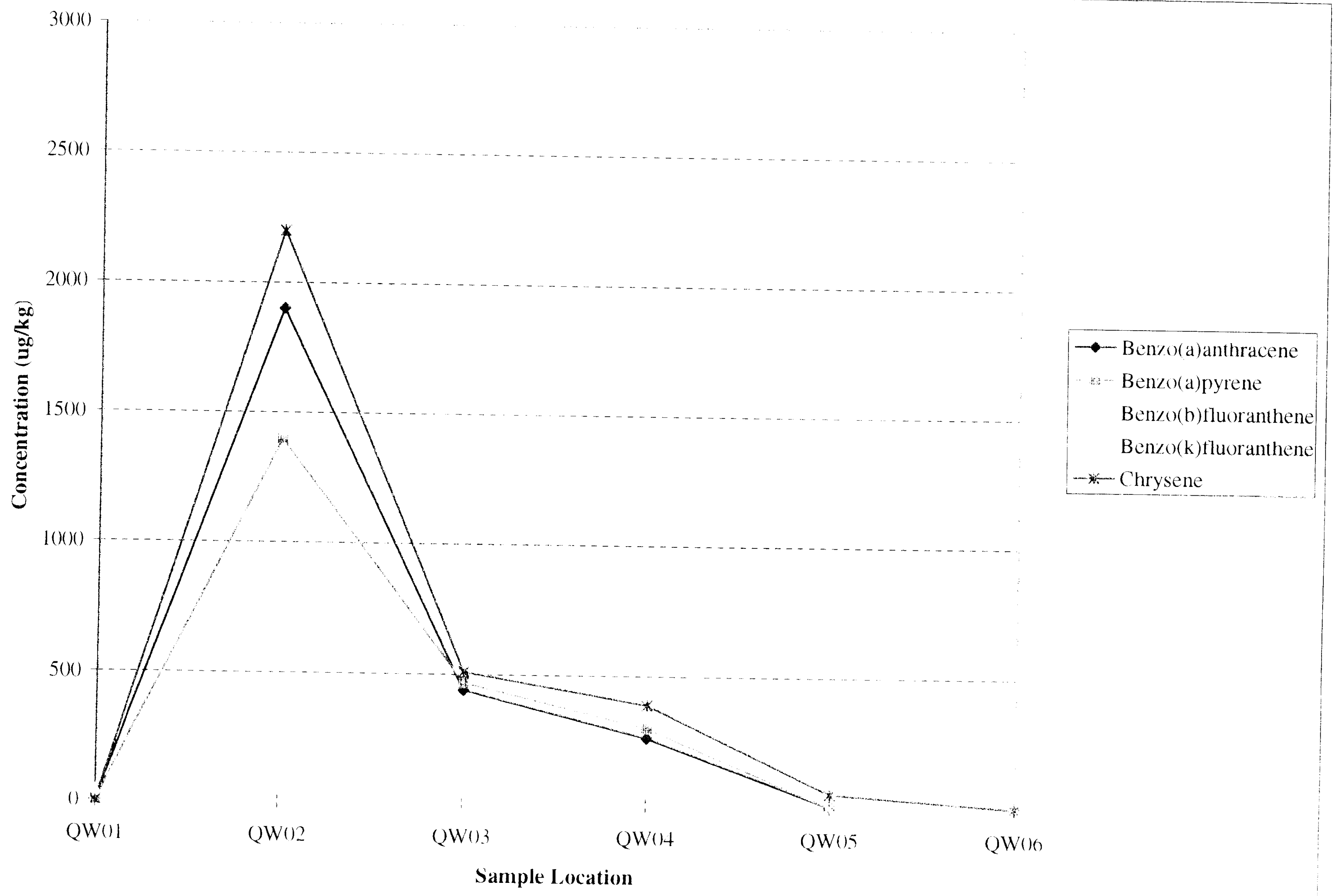

FIGURE 5-4e

WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

1Qtr2Yr - October 1995

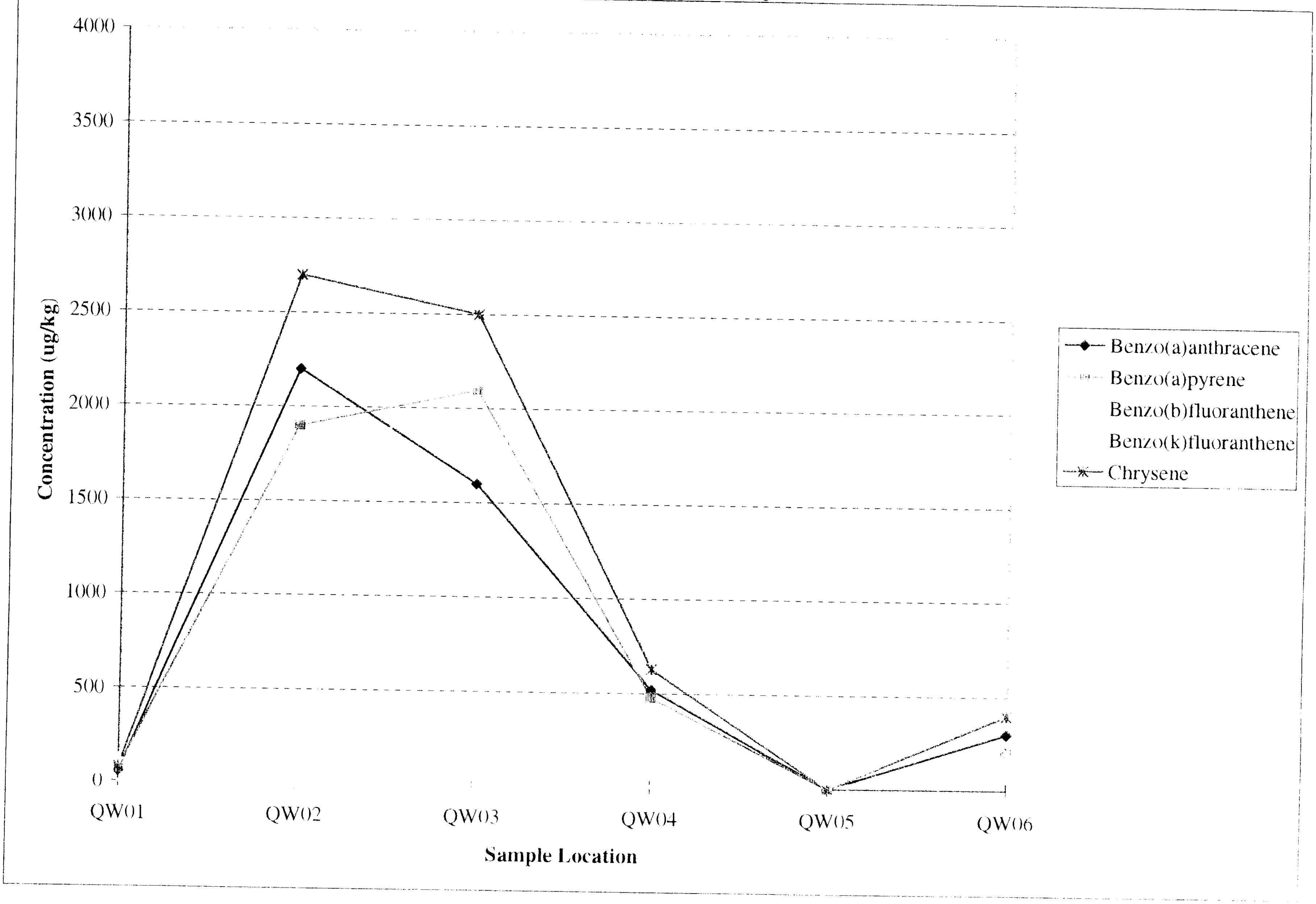

FIGURE 5-4f
WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
2Qtr2Yr - March 1996

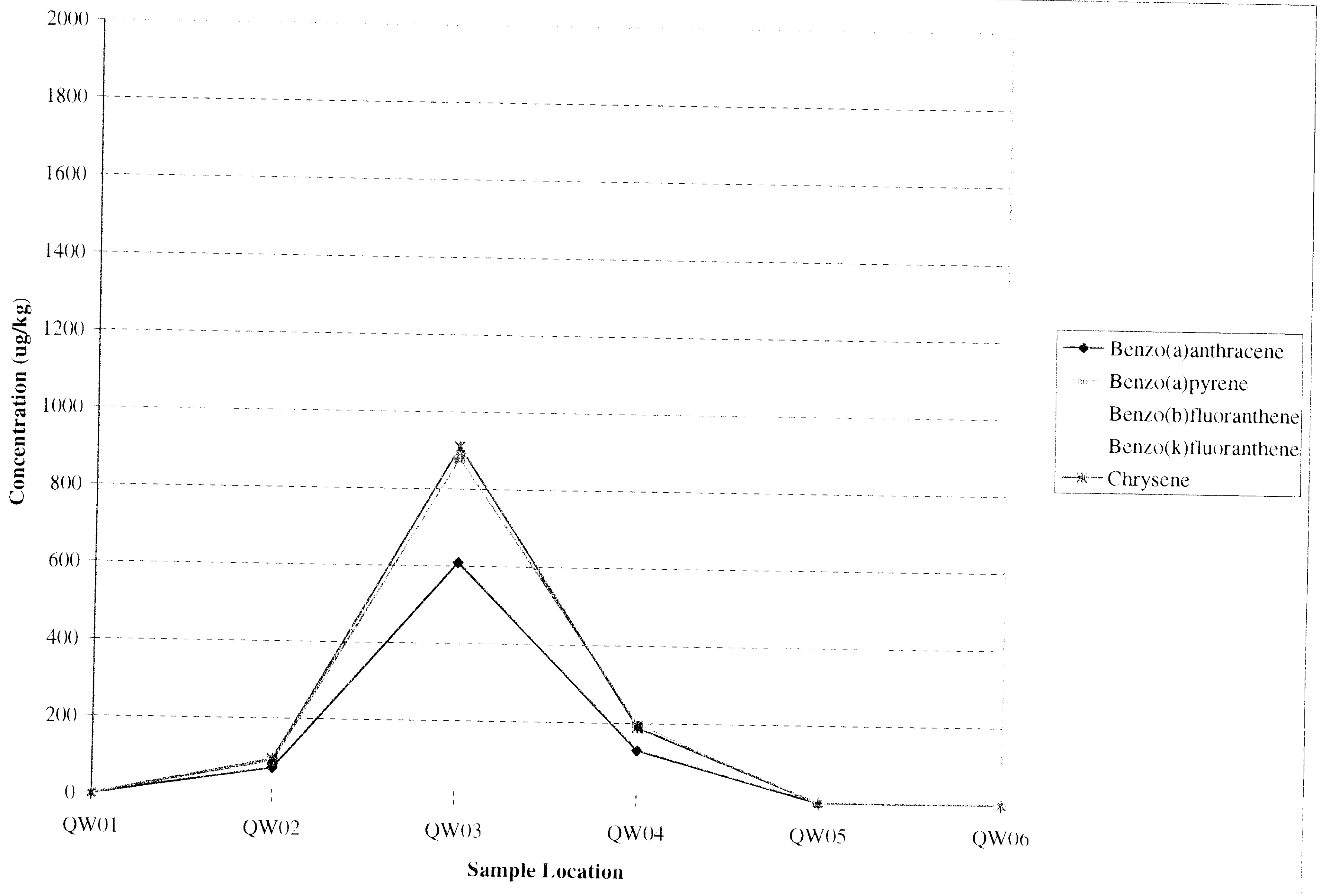

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FIGURE 5-4g
WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
3Qtr2Yr - May 1996

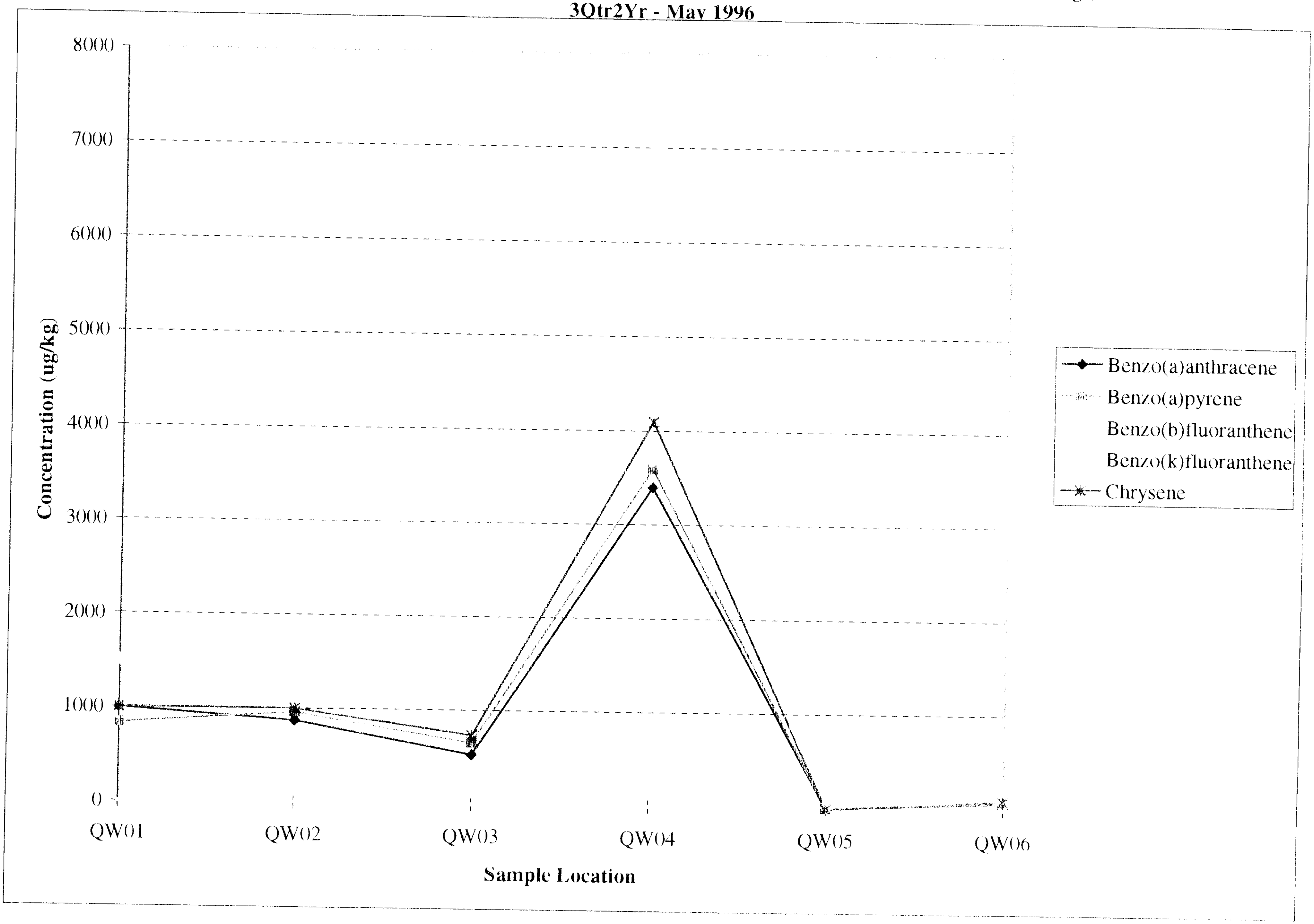

FIGURE 5-4h
WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
4Qtr2Yr - Aug 1996

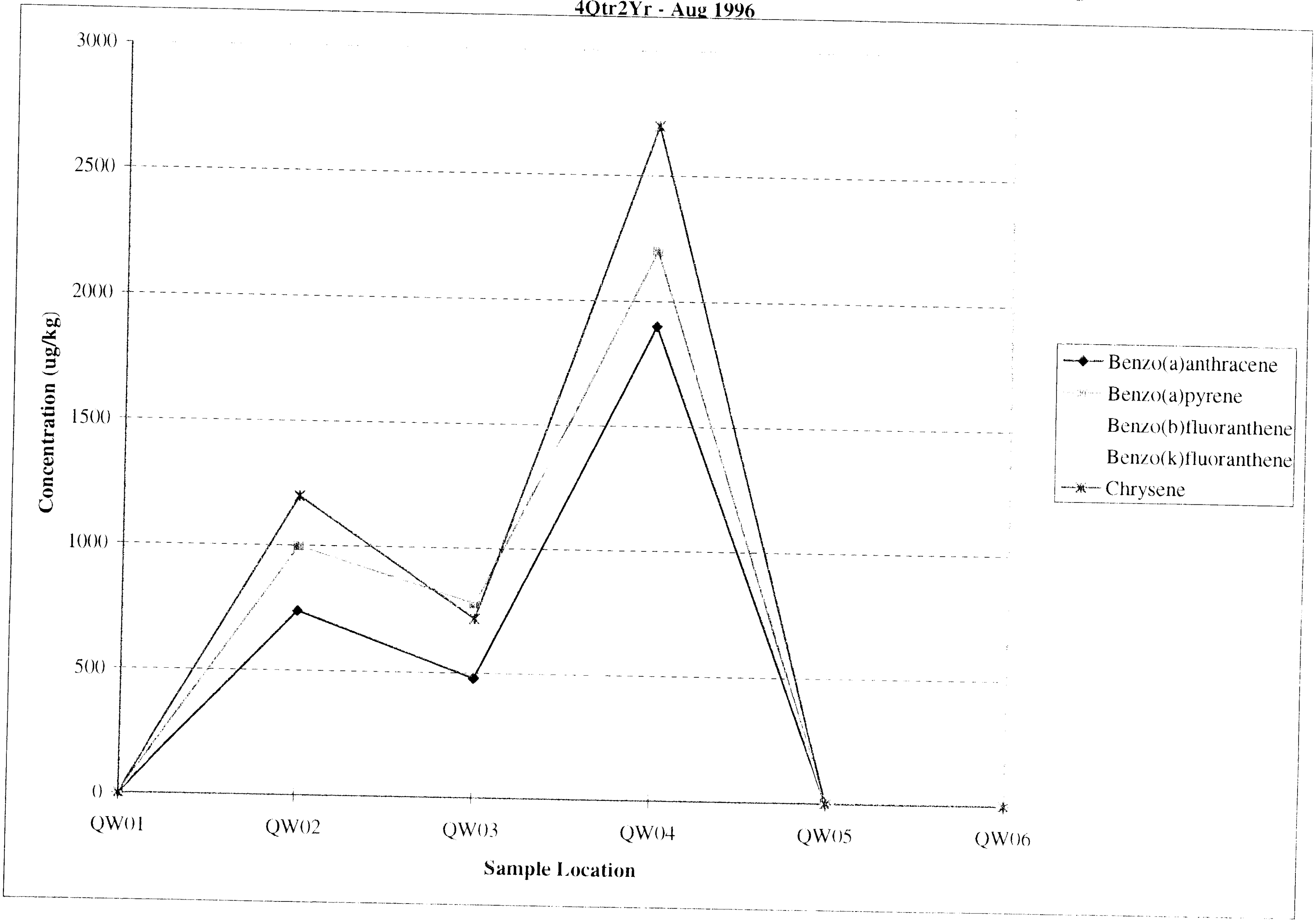

FIGURE 5-4i

WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

1Evnt3Yr - Jan 1997

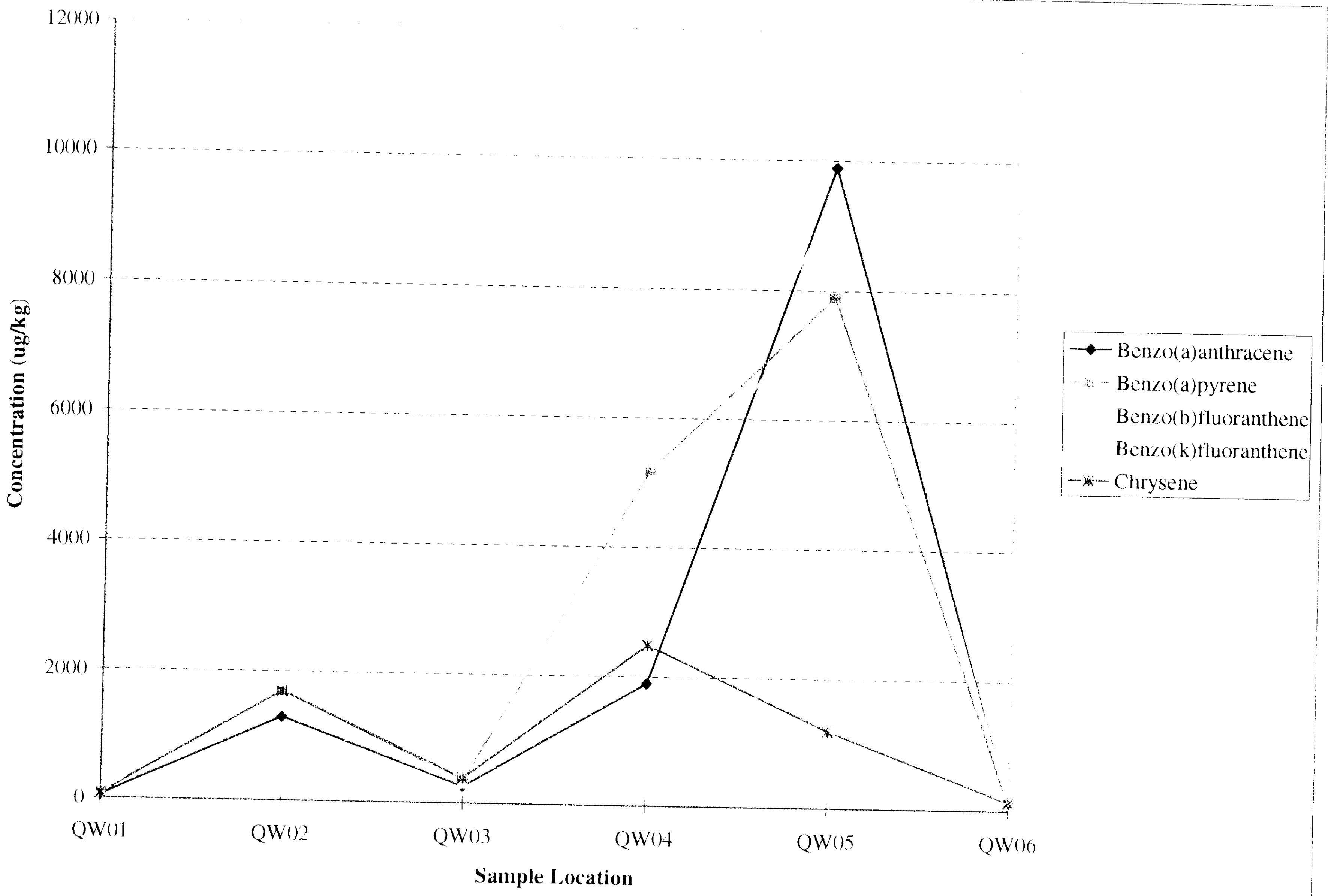

FIGURE 5-4j
WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
2Evnt3Yr - Jul 1997

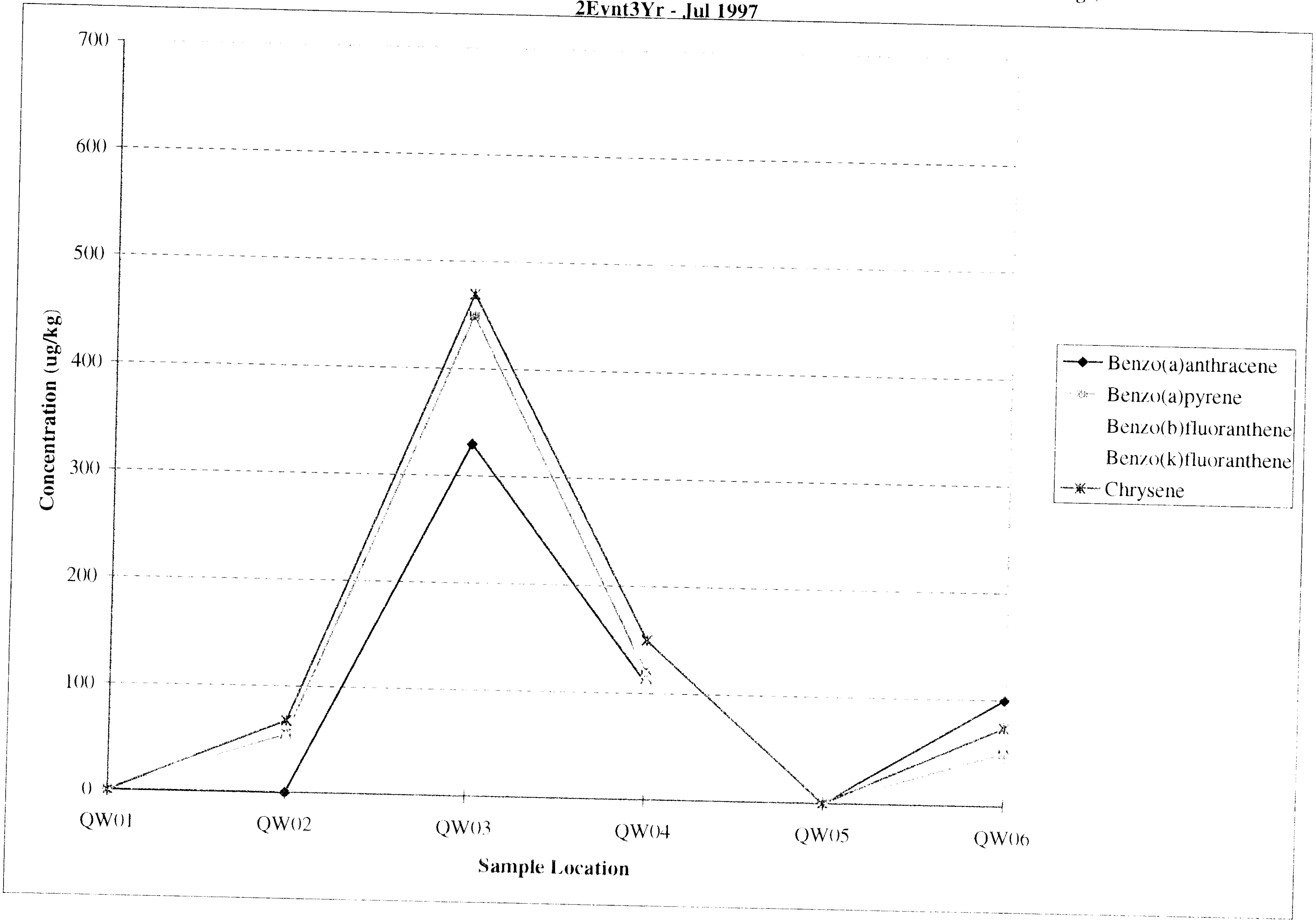

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FIGURE 5-4k
WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)
1Evnt4Yr - January 1998

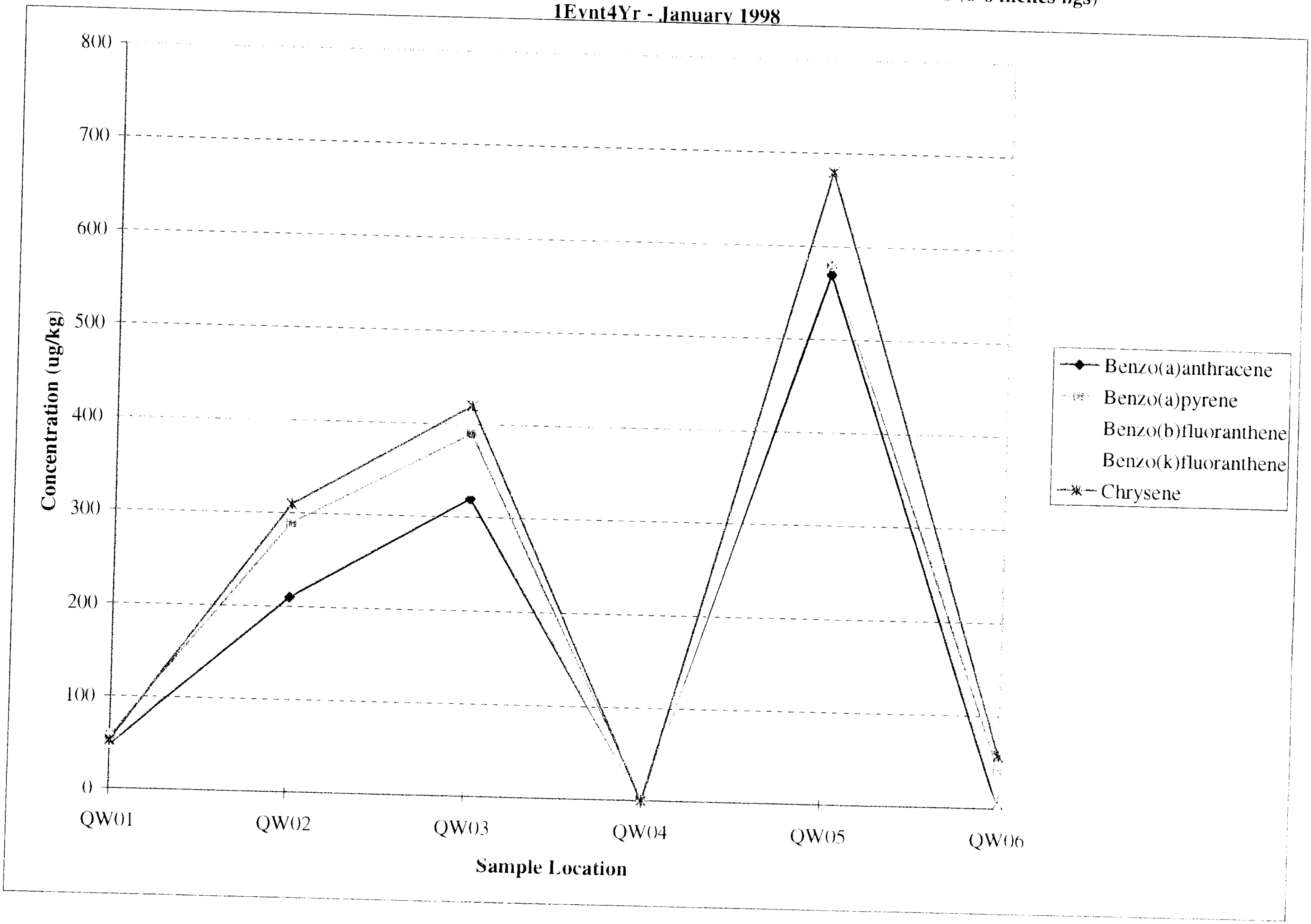

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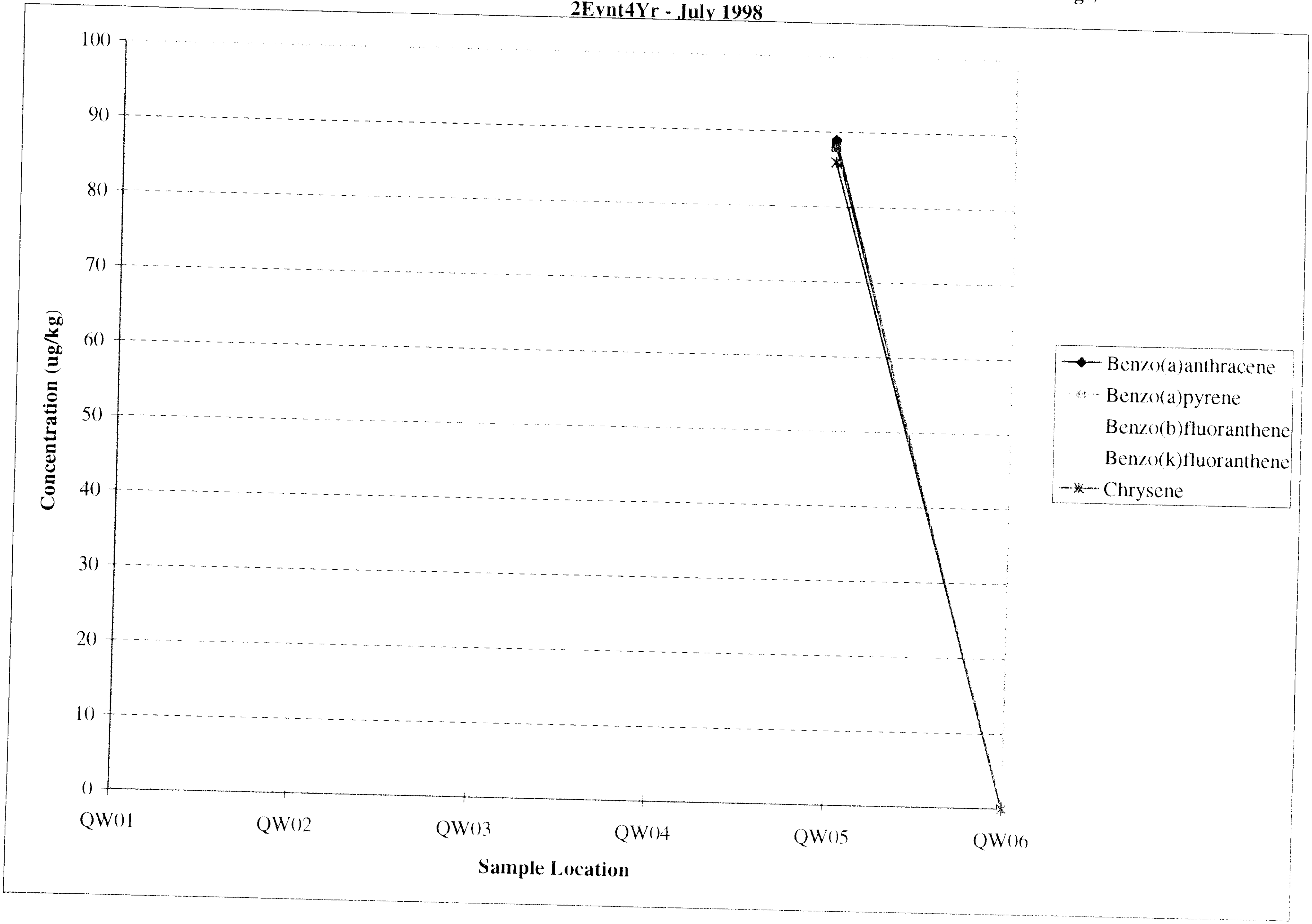
FIGURE 5-4l

WEST SOLDIER CREEK SEDIMENT PAH CONCENTRATION GRADIENT (0-6 inches bgs)

2Evnt4Yr - July 1998



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6. CONCLUSIONS

The following discussion presents a summary of screening criteria exceedances during the fourth year of monitoring. BHRA 10^{-6} screening criteria were exceeded by five semivolatile (SVOCs) classified as polyaromatic hydrocarbons (PAHs). These include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and chrysene. HHRA I 10^{-6} screening criteria were exceeded by five PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. HHRA I 10^{-5} screening criteria were exceeded by benzo(a)pyrene and dibenz(a,h)anthracene in sediment samples.

Sediment analyte concentrations from the fourth year of monitoring did not exceed the 10^{-4} screening criteria set forth in the BHRA and the HHRA I. However, the HHRA I noncarcinogenic hazard screening criteria for aroclor 1254 was exceeded at one location in segment QW03 on West Soldier Creek.

Due to the sampling methodology, care must be taken when drawing inferences on temporal trends of compound concentrations. However, several trends in the detected analytes from sediment samples appear to be present.

- The detected PAH concentrations in the sediment appear to follow the same trend (e.g., an increase in one PAH compound is associated with increases in the other detected PAH compounds).
- The sampling segment with the highest PAH concentrations in the sediment varies between monitoring events. This relationship suggests that multiple origins for PAHs could exist.
- Analyte concentrations are seen to decrease off-base as compared to on-base.

Surface water analyte concentrations from the fourth year of monitoring did not exceed any of the screening criteria set forth in the BHRA or HHRA I noncarcinogenic, 10-4 or 10-5 screening criteria. During the 1E4Y event the HHRA 10-6 screening criteria for bis(2-Ethylhexyl)phthalate) was exceeded at one location at segment QE02 on East Soldier Creek.

The results of the risk characterization indicate that for all scenarios, potential cancer risks are below or within the USEPA advisory range of 10^{-6} to 10^{-4} and the USEPA noncarcinogenic health hazard of 1.0. These results indicate that exposure to surface water and sediments in West and East Soldier Creeks is not likely to result in an unacceptable cancer risk or noncarcinogenic hazard for any on-base or off-base populations under current or future stream use conditions.

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APPENDIX A

HUMAN HEALTH RISK ASSESSMENT IV

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EXECUTIVE SUMMARY

This document presents the results of the human health risk assessment (RA) of Soldier Creek surface water and sediment at Tinker Air Force Base (AFB), Oklahoma City, Oklahoma. Soldier Creek surface water and sediment are sampled semi-annually as part of long-term monitoring of Soldier Creek. Previously, Black & Veatch Waste Science Technology (B&V 1993) and Woodward-Clyde Federal Services (1996, 1997b, 1997c) evaluated potential risks associated with Soldier Creek surface water and sediment using data available at the time of their assessments. This human health RA evaluates the potential current and future risks associated with Soldier Creek surface water and sediment based on the most recently measured surface water and sediment concentrations (January and July 1998 semi-annual Soldier Creek monitoring). The results from this current assessment were compared with the results from the three previous WCFS RAs (WCFS 1996, 1997b, 1997c) to determine if the earlier conclusions are still valid and if there are any trends associated with the calculated risks. Additionally, remediation goals protective of human health developed by WCFS (1997c) for surface water and sediment were updated in this report.

This RA incorporates the methodology described in the *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A* (RAGS; USEPA 1989a), *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part B* (USEPA 1991b), *Exposure Factors Handbook* (USEPA 1989b), *Standard Default Exposure Factors* (USEPA 1991a), *Dermal Exposure Assessment: Principles and Applications* (USEPA 1992a), and *Supplemental Region IV Risk Assessment Guidance* (USEPA 1996). Toxicity data were obtained from USEPA's Integrated Risk Information System (IRIS; USEPA 1998a), Health Effects Assessment Summary Tables (HEAST; USEPA 1997), and USEPA Region III's Risk-based Concentration Table (USEPA 1998b). Surface water and sediment data collected from Soldier Creek during the January and July 1998 semi-annual monitoring were evaluated.

Soldier Creek was divided into three different areas for analysis in the RA based on different contaminant sources and exposed populations. The three segments are:

- Off-Base West Soldier Creek
- On-Base East Soldier Creek

- Off-Base East Soldier Creek

Tinker AFB began remediation of the on-Base portion of West Soldier Creek in July 1998. This remediation includes excavating sediment and lining the channel with concrete. Consequently, surface water and sediment samples were not collected from the area of the on-Base segment of West Soldier Creek undergoing remediation during July 1998 and a risk evaluation was not conducted for the on-Base segment of West Soldier Creek.

An evaluation of potential human health risks was performed for surface water and sediment in the three stream segments for the chemicals of potential concern (COPCs). The COPCs identified for the different stream segments include metals, polychlorinated biphenyls (PCBs), pesticides, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). Exposure scenarios believed to represent potential human activities in the stream segments were evaluated. These exposure scenarios were developed in the previous RAs and for consistency were evaluated in this assessment. The exposure scenarios evaluated include:

- Construction workers involved in repair or installation of underground pipelines around or under on-Base portions of East Soldier Creek; and

- Residents wading or swimming in off-Base portions of West and East Soldier Creeks.

Based on the depth of water, swimming was only evaluated for the residential child scenario for off-Base East Soldier Creek; all other scenarios assume wading only. Exposure to both surface water and sediment was evaluated for all receptors.

Potential cancer risks are below or within the USEPA recommended range of 10^{-6} to 10^{-4} and potential noncarcinogenic hazards are below the USEPA recommended noncarcinogenic health hazard of 1.0 for all scenarios. These results indicate that exposure to surface water and sediment in West and East Soldier Creeks is not likely to result in an unacceptable cancer risk or noncarcinogenic hazard for on-Base or off-Base populations under current or future stream use and current environmental conditions.

The results of the current risk analysis were compared to the results from the three previous RAs (WCFS 1996, 1997b, 1997c). It should be noted that the methodology used in the current risk analysis was slightly different than the methodology used in the three previous RAs. The 1996 USEPA Region IV Supplemental Risk Guidance (USEPA 1996) was followed for this assessment and the 1991 USEPA Region IV Guidance (USEPA 1991d) was followed for the previous assessments. The largest difference between the current and the previous RAs was the methodology used to select the COPCs, which resulted in different COPCs being selected. Therefore, the risk assessments are not completely comparable. In general, no dramatic changes between the first three WCFS RAs and the current (fourth year) RA were identified. . The differences in estimated noncarcinogenic hazards and carcinogenic risks are due to changes in contaminant concentrations and the chemicals that were detected in the sediment and surface water. These differences are expected because the stream is a dynamic system affected by factors such as precipitation levels. Effluent outfall flow and concentrations also impact the dynamics of the stream system. Like heavy precipitation, large volumes of effluent outfall may dilute concentrations in the stream system. Therefore, it is possible for concentrations in the stream to rise despite the closure of outfalls. The differences between the current fourth year RA and the three previous RAs may also be attributed to the use of a different method to select the COPCs for quantitative evaluation in the RA. Despite slightly different methodologies, the calculated risks still do not pose an unacceptable risk to human health.

To date, none of the RAs indicated any unacceptable adverse noncarcinogenic health effects or cancer risks associated with exposure to West or East Soldier Creeks for any on-Base or off-Base population under current or future stream use conditions. Consequently, no remedial action is necessary based on risks to human health. As part of the RA, health-protective cleanup goals were developed for each COPC. Although remediation is not currently warranted based on risk to human health, the cleanup goals provide a set of "action criteria" should remediation be required in the future.

1.0 INTRODUCTION

This report presents the results of an assessment of potential human health risks associated with the surface water and sediment in Soldier Creek at the Tinker Air Force Base (AFB), Oklahoma City, Oklahoma. Analytical results from 1998 semi-annual surface water and sediment monitoring were used to evaluate potential human health risks. The potential current and future human health risks for Soldier Creek were characterized assuming current site conditions remain unchanged and no additional remediation is implemented. This RA was prepared using conservative assumptions, and the maximum exposed receptors were considered based on current and potential future site usage.

The organization of this RA follows the basic structure presented in the *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A* (RAGS; USEPA 1989a). In addition, sections have been included on trend analysis with the three previous Woodward-Clyde Federal Services RAs (WCFS 1996, 1997b, 1997c) and the development of Remedial Action Objectives (RAOs). The RA is comprised of the following sections:

- **Introduction** - A discussion of pertinent site background information

- **Identification of Chemicals of Potential Concern** - Identification of chemicals of potential concern (COPCs) for each of the three stream segments under investigation

- **Exposure assessment** - Identification of potentially exposed populations and the exposure parameters and exposure concentrations used to quantify chemical uptake by those populations

- **Toxicity assessment** - Assessment of the potential adverse effects of the COPCs

- **Risk Characterization** - Estimation of the potential cancer risks and noncarcinogenic hazards associated with exposure to the COPCs by the exposed populations

- **Development of RAOs** - Development of RAOs for the COPCs

- **Uncertainty Analysis** - Identification of sources of uncertainties associated with each step of the RA, and the likely impact of these uncertainties on the results and conclusions of the RA

- **Risk trend analysis** – Comparison of the results of the current RA to the results from the three previous WCFS RAs

- **Conclusions and recommendations** – Conclusions and recommendations based on results of the RA

1.1 SITE DESCRIPTION

Tinker Air Force Base (AFB) is located within the corporate limits of Oklahoma City, Oklahoma, approximately seven miles east-southeast of Oklahoma City's inner-core metropolitan area (Figure 1-1). Midwest City borders the AFB to the north, Del City to the northwest, and Oklahoma City to the east, south, and southwest. The boundaries of Tinker AFB are defined by Sooner Road to the west, Douglas Boulevard to the east, Southeast 29th Street to the north, and Southeast 74th Street to the south. Midwest City and Del City are heavily populated with both residential and commercial areas. The area under Oklahoma City jurisdiction is lightly developed residential. Tinker AFB lies within an area representing a transition from residential and industrial/commercial land use on the north and west to agricultural land use to the east and south.

The principal surface water drainage pathways for Tinker AFB are Crutcho, Kuhlman, and Soldier Creeks (Figure 1-1). The main channel of Soldier Creek is located to the east of Tinker AFB, flowing north from its headwaters near Southwest 59th Street to its confluence with Crutcho Creek. Two tributaries to Soldier Creek originate on the Base. For the purpose of this RA, the tributary of Soldier Creek east of Building 3001 is identified as East Soldier Creek and the tributary west of Building 3001 is identified as West Soldier Creek. East Soldier Creek originates north of Building 3705, flows northward along the east side of Building 3001, past the Industrial Wastewater Treatment Plant (IWTP), and drains into

Soldier Creek approximately one mile downstream. West Soldier Creek originates west of Building 3001 and flows northward approximately two miles to its confluence with Soldier Creek.

The current scope of investigation, as identified in the Work Plan (AWCFS 1994), includes the portions of East and West Soldier Creek from their points of origin to their intersection with Interstate 40, north of the base. The reasoning behind the study boundaries can be found in the 4th Year, 1st Event Sampling Report, April 1998..

1.2 SITE OPERATIONS AND REGULATORY HISTORY

Tinker AFB is an active United States Air Force industrial facility responsible for the maintenance of a wide variety of military aircraft. Tinker AFB was activated in March of 1942 under the name of Midwest Air Depot. During World War II, the depot was responsible for reconditioning, modifying, and modernizing aircraft, vehicles, and equipment. The primary mission has not changed. Tinker AFB is still a major industrial complex for overhauling, modifying, and repairing military aircraft engines and accessory items.

As part of the Air Force Installation Restoration Program (IRP), Tinker AFB began investigating previously used disposal sites in 1981 (USEPA 1988). A Base-wide sampling program was conducted in 1983. Analytical results from the sampling program indicated trichloroethene (TCE) was present in the groundwater. Tinker AFB, through the Tulsa District Corps of Engineers (COE), conducted remedial investigations from 1986 to 1989 to determine the nature and extent of groundwater contamination. The investigations determined that chromium and TCE were chemicals of concern (COCs) in groundwater. On July 22, 1987, the Building 3001 and the Soldier Creek sites were added to the National Priorities List (NPL). In 1990 and 1991, B&V conducted a Phase I and Phase II Remedial Investigation/Feasibility Study (RI/FS) to determine the extent of sediment and surface water contamination along East, West, and Main Soldier Creek. As part of the RI, B&V performed a baseline human health RA and concluded that sediment and surface water in Soldier Creek did not pose an unacceptable risk to human health (B&V 1993). WCFS prepared subsequent RAs and again found that the sediment and surface water in East and West Soldier Creeks did not pose an unacceptable risk to human health (WCFS 1996, 1997b, 1997c).

Since submission of the RI/FS reports, Tinker AFB has reduced or eliminated releases to Soldier Creek from several outfalls, including the IWTP outfall, which was closed in April of 1996.

The IWTP, located in the northeastern portion of the Base, receives industrial process discharge waters from the Building 3001 complex and other buildings and operations in the area through a series of underground lines. These waters were treated and discharged to East Soldier Creek under a National Pollutant Discharge Elimination System (NPDES) permit. The IWTP is currently used as a pretreatment facility and no longer discharges to East Soldier Creek on a regular basis. However, the IWTP outfall is still permitted for use in case of emergency. In the past, a sanitary wastewater treatment facility also discharged to East Soldier Creek under the same permit as the IWTP. Sanitary waste currently discharges directly to the Oklahoma City POTW.

NUS Corporation (1989) conducted a storm sewer investigation to characterize the sources of the outfalls from Tinker AFB to Soldier Creek. This study identified the following four categories of waste discharge:

1) process discharge, such as cooling tower blowdown,
2) low volume sources, such as oils derived from compressors, vacuum pumps and fume handling systems,
3) cross-contamination between waste systems and storm sewers, and
4) inappropriate disposal of wastes, such as solvents and lubricating oils, into floor drains and catch basins (believed to represent the primary source of contamination to Soldier Creek).

Discharges from the various Tinker AFB outfalls represent semi-continuous sources to both East and West Soldier Creeks. It is likely that the Tinker AFB outfalls will have year-round influence on surface water quality, while site runoff is more likely to influence surface water in a seasonal fashion.

1.3 SITE PHYSICAL SETTING

Tinker AFB is located in an area characterized by gently rolling hills, broad flat plains, and well-entrenched main streams. Ground elevations range from 1,210 feet above mean sea level (MSL) on the northwest side of the Base to about 1,320 feet above MSL at the southeast corner of the Base (Radian 1985). Historic data from the Tinker AFB weather station indicate that the average annual precipitation at Tinker AFB is approximately 34 inches per year. Rainfall occurs in a distinct, seasonal pattern ranging from a high of 5.8 inches in May to a low of 1.2 inches in January (Parsons 1996).

Soldier Creek and its tributaries receive surface runoff from approximately 9,000 acres. Tinker AFB's easternmost runway areas and the Building 3001 complex contribute surface water runoff and/or effluent discharge to Soldier Creek. The Building 3001 complex consists of an aircraft overhaul and modification complex to support the mission of the Oklahoma City Air Logistics Center.

1.4 OBJECTIVES AND SCOPE OF THE HUMAN HEALTH RISK ASSESSMENT

Three previous RAs for East and West Soldier Creeks surface water and sediment were performed by WCFS (1996, 1997b, 1997c). The purpose of this RA is to provide information on potential current and future human health risks based on current contaminant levels. The results from this RA will be compared to the results of the three previous RAs to determine if the previous conclusions are still valid. This RA was based on the same exposure scenarios and the majority of the exposure assumptions that were used in the previous RAs so that the results could be compared with the previous results. However, the methodology used for the three previous assessments was updated to be consistent with the current USEPA Region IV Guidance (USEPA 1996). Therefore, the risk assessments are not completely comparable. The greatest difference between the 1996 and 1992 USEPA Region IV Guidance documents is the process used to select COPCs. This RA also updated the cleanup goals developed in the previous RA (WCFS 1997c) for stream surface water and sediment based on the protection of human populations.

USEPA guidance documents used to conduct the RA include RAGS (USEPA 1989a), *Exposure Factors Handbook* (USEPA 1989b), *Standard Default Exposure Factors* (USEPA

1991a), Integrated Risk Information System on-line database (IRIS; USEPA 1998a), *Dermal Exposure Assessment: Principles and Applications* (USEPA 1992a), *Supplemental Region IV Risk Assessment Guidance* (USEPA 1996), and *Risk Assessment Guidance for Superfund Part B, Development of Risk-based Preliminary Remediation Goals* (USEPA 1991b).

Soldier Creek was separated into three segments for evaluation in the RA. Because the contaminants and contaminant sources in East Soldier Creek are different from those in West Soldier Creek, East and West Soldier Creeks were evaluated separately. Additionally, the on-Base stream segments were evaluated separately from the off-Base segments because of the differences in the potentially exposed populations. The stream segments that were evaluated in this RA are the same as those evaluated in the three previous RAs (WCFS 1996, 1997b, 1997c), with the exception that the on-Base portion of West Soldier Creek was not evaluated in the current RA. Tinker AFB began remediation of the on-Base portion of West Soldier Creek in July 1998. This remediation includes excavating sediment and lining the channel with concrete. Consequently, surface water and sediment samples were not collected from the on-Base segment of West Soldier Creek during the July 1998 semi-annual sampling. The stream segments evaluated in this RA include:

- Off-Base West Soldier Creek
- On-Base East Soldier Creek
- Off-Base East Soldier Creek

FIGURES

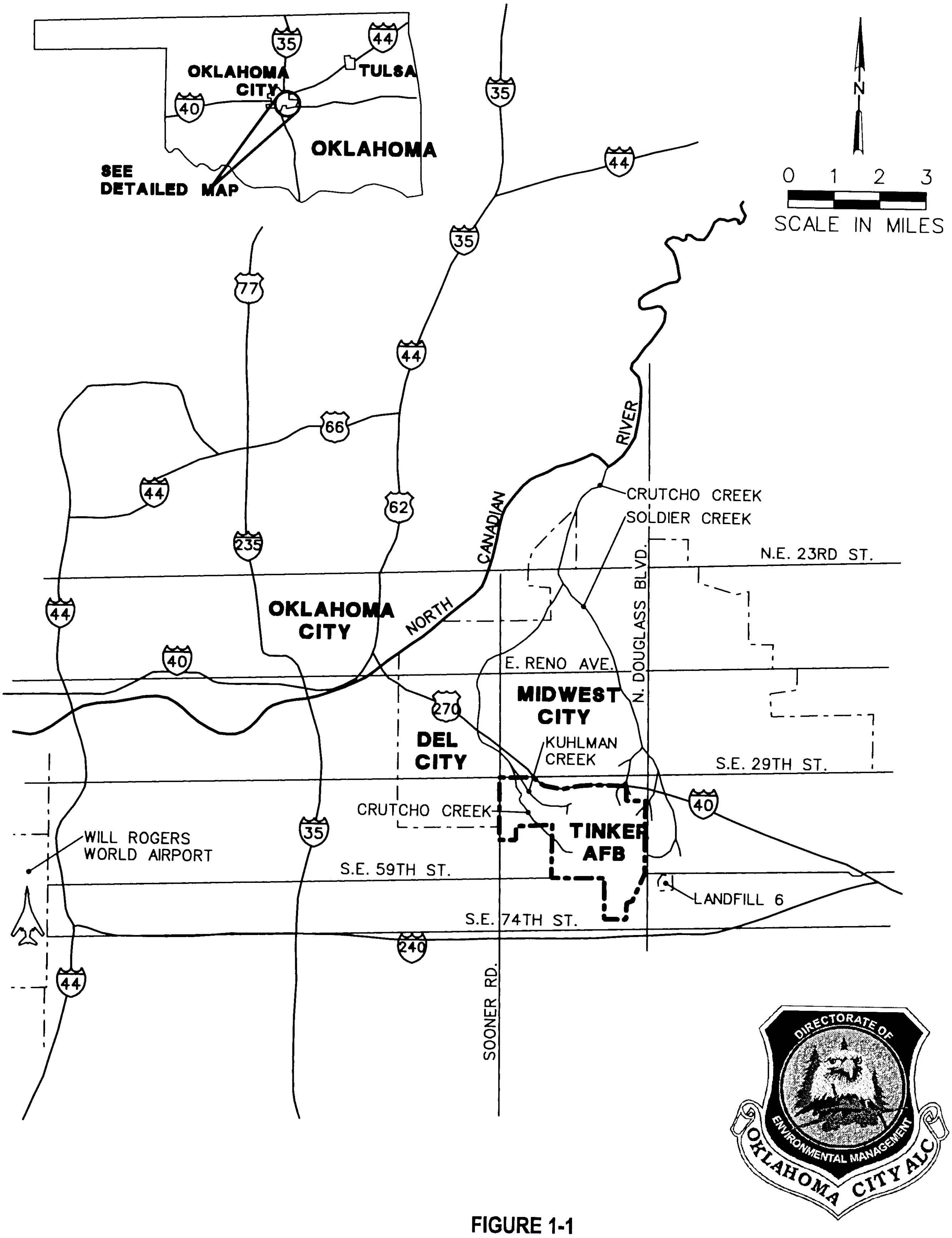

FIGURE 1-1
Tinker Air Force Base Vicinity Map
Tinker Air Force Base, Oklahoma City, Oklahoma

2.0 CHEMICALS OF POTENTIAL CONCERN

The first step in the RA was the identification of COPCs for quantitative evaluation. The COPCs represent those chemicals that pose the greatest risk to human health at the site. Thus, the quantification of potential health risks posed by the site can be focused on the COPCs without significantly underestimating the total risk. COPCs were selected separately for sediment and surface water for each of the three stream segments evaluated in the RA. The COPC selection process used in this RA was different from the process used in the three previous RAs. The COPC selection process was updated to be consistent with more recent USEPA Region IV Guidance (USEPA 1996). This section begins with an identification of the data evaluated in the RA, followed by a discussion of the COPC selection process, and identification of the COPCs.

2.1 DATA

Surface water and sediment samples were collected from Soldier Creek in January and July of 1998. Figure 2-1 identifies the Soldier Creek sampling locations. The samples were analyzed for volatile organic constituents (VOCs), semivolatile organic constituents (SVOCs), PCBs/pesticides, and metals. As discussed previously, three separate areas were evaluated in the RA. Table 2-1 lists the sampling locations associated with each area.

2.2 SELECTION OF COPCS

Although the analytical results identified a number of chemicals present in sediment and surface water samples from East and West Soldier Creek, not all of these chemicals are likely to pose risks to human health. Therefore, the data were screened following the method described below to focus the assessment on those chemicals of greatest potential concern for human health. Compounds were systematically excluded based on the following criteria:

- The compound was not detected in any sample.
- The compound was identified as a laboratory contaminant.

- The compound was detected at a concentration below the risk-based screening concentration.
- The compound is an essential nutrient and has a low inherent toxicity.
- The compound was detected at background levels.

The following sections present the COPC selection process and final lists of COPCs for surface water and sediment from East and West Soldier Creeks (on-Base and off-Base). Tables 2-2 through 2-7 list the chemicals analyzed for in the different stream segments and media, indicate if the chemical was selected as a COPC, and include the reason for exclusion if the chemical was not selected as a COPC.

- Table 2-2: Surface water from off-Base portion of West Soldier Creek.
- Table 2-3: Surface water from on-Base portion of East Soldier Creek
- Table 2-4: Surface water from off-Base portion of East Soldier Creek.
- Table 2-5: Sediment from off-Base portion of West Soldier Creek.
- Table 2-6: Sediment from on-Base portion of East Soldier Creek.
- Table 2-7: Sediment from of-Base portion of East Soldier Creek.

2.2.1 Chemicals Not Detected

Chemicals that were not detected in a specific stream segment and medium were excluded from the COPC list for that stream segment and medium. The COPC summary tables (Tables 2-2 through 2-7) list the chemicals excluded from the COPC list because they were not detected.

2.2.2 Laboratory Contaminants

Chemicals, which were qualified with a 'B' (indicating blank contamination) by the laboratory, in all samples in which they were detected in a specific stream segment and media, were assumed not detected in the site media and were excluded from the COPC list. Chemicals that are common laboratory contaminants are qualified with a 'B' if the concentration in the sample is not greater than ten times the concentration in the associated blank sample. Common laboratory contaminants include acetone, 2-butanone, methylene chloride, toluene, and phthalate esters. Chemicals that are not common laboratory contaminants are qualified with a 'B' if the concentration in the sample is not greater than five times the concentration in the associated blank sample. Constituents for which all detects were qualified with a B within a data grouping are indicated as not detected in Tables 2-2 through 2-7 and were not retained as COPCs.

2.2.3 Risk-Based Screening

Chemicals detected in the surface water were compared to the Water Quality Standard for human health for the consumption of water and organisms (WQS; from 40 CFR 131.36, July 1, 1997). If the maximum detected concentration of a chemical was below the WQS, that chemical was not retained as COPC for that media and data grouping.

The maximum detected chemical concentration in sediment was compared to the USEPA Region III Risk-Based Concentration (RBC) for residential soil ingestion (USEPA 1998b). The RBCs in the USEPA Region III RBC Table for noncarcinogenic chemicals are based on a hazard index of 1.0. These RBCs were adjusted to a hazard index of 0.1 for the risk-based screening. The RBCs for carcinogenic chemicals were not adjusted and are based on a carcinogenic risk of $1x10^{-6}$.

Tables 2-8 through 2-13 present the risk-based screening and indicate which chemicals were retained as COPCs based on this step of the COPC selection process.

2.2.4 Essential Nutrients

Chemicals that are essential nutrients, present at low concentrations only slightly above naturally occurring levels, and toxic only at very high doses were excluded from consideration in the RA (USEPA 1989a). Chemicals that were considered essential nutrients in this assessment are calcium, magnesium, potassium, and sodium (USEPA 1996). The estimated intakes of essential nutrients detected in surface water and sediment were compared with the recommended daily allowances (RDAs) established by the National Research Council (NRC 1989). The estimated daily intake was calculated assuming that an individual ingests 0.5 L/day of surface water (upper-bound water ingestion rate assuming 10 hours of swimming) or 100 mg/kg of sediment (upper-bound daily soil ingestion rate for adults).

Tables 2-14 through 2-19 show the comparison of the intake of essential nutrients to their RDAs and indicate which chemicals were retained as COPCs.

2.2.5 Chemicals Present at Background Concentrations

The maximum detected concentrations of inorganic constituents were compared to naturally occurring background concentrations to identify constituents that are not associated with site contamination. The average concentrations from samples collected from an upstream, off-Base portion of Crutcho Creek (PES 1996) were considered representative of background concentrations. Chemicals detected at concentrations within two times the average background concentrations were assumed to be present at background levels (USEPA 1996), and were not included on the COPC list. Tables 2-20 through 2-25 compare the maximum detected concentration to two times the background concentration and indicate if the chemical was retained as a COPC.

2.3 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

The COPCs were selected based on the criteria discussed above for each environmental medium (surface water and sediment) in each stream segment. The constituents retained as COPCs are further evaluated in the quantitative RA to determine whether they may contribute risks to the human receptors discussed in Section 3.0. Tables 2-26 through 2-31 list the maximum and minimum detected concentrations and the frequency of detection for the COPCs, as follows:

- Table 2-26: COPCs for surface water in the off-Base portion of West Soldier Creek.

- Table 2-27: COPCs for surface water in the on-Base portion of East Soldier Creek.

- Table 2-28: COPCs for surface water in the off-Base portion of East Soldier Creek.

- Table 2-29: COPCs for sediment in the off-Base portion of West Soldier Creek.

- Table 2-30: COPCs for sediment in the on-Base portion of East Soldier Creek.

- Table 2-31: COPCs for sediment in the off-Base portion of East Soldier Creek.

TABLES

TABLE 2-1

SAMPLING LOCATIONS IN EACH STREAM SEGMENT

AREA	SAMPLE LOCATION
Off-Base West Soldier Creek	QW05 QW06
On-Base East Soldier Creek	QE01 QE02 QE03 QE04 QE05 QE06 QE07 QE08 QE09
Off-Base East Soldier Creek	QE10 QE11

TABLE 2-2

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Metals				
Aluminum	4 / 4	0.45	No	Below Background
Antimony	2 / 4	0.0018	No	Below WQS
Arsenic	0 / 4		No	Not Detected
Barium	4 / 4	0.43	No	Below Background
Beryllium	0 / 4		No	Not Detected
Cadmium	2 / 4	0.0003	Yes	
Calcium	4 / 4	53.2	No	Below RDA
Chromium	4 / 4	0.012	Yes	
Cobalt	2 / 4	0.00016	Yes	
Copper	4 / 4	0.0055	No	Below Background
Iron	4 / 4	0.59	No	Below Background
Lead	4 / 4	0.0019	No	Below Action Level
Magnesium	4 / 4	23.4	No	Below RDA
Manganese	4 / 4	0.047	No	Below Background
Mercury	2 / 4	0.000064	No	Below WQS
Molybdenum	4 / 4	0.0035	Yes	
Nickel	4 / 4	0.0062	No	Below WQS
Potassium	2 / 4	1.3	No	Below RDA
Selenium	2 / 4	0.0011	Yes	
Silver	1 / 4	0.000081	Yes	
Sodium	4 / 4	24.2	No	Below RDA
Thallium	2 / 4	0.000038	No	Below WQS
Vanadium	4 / 4	0.014	Yes	
Zinc	4 / 4	0.039	No	Below Background
PCBs/Pesticides				
4,4'-DDD	0 / 4		No	Not Detected
4,4'-DDE	0 / 4		No	Not Detected
4,4'-DDT	0 / 4		No	Not Detected
Aldrin	0 / 4		No	Not Detected
alpha-BHC	0 / 4		No	Not Detected
alpha-Chlordane	0 / 4		No	Not Detected
Aroclor 1016	0 / 4		No	Not Detected
Aroclor 1221	0 / 4		No	Not Detected
Aroclor 1232	0 / 4		No	Not Detected
Aroclor 1242	0 / 4		No	Not Detected
Aroclor 1248	0 / 4		No	Not Detected
Aroclor 1254	0 / 4		No	Not Detected
Aroclor 1260	0 / 4		No	Not Detected
beta-BHC	0 / 4		No	Not Detected
delta-BHC	0 / 4		No	Not Detected
Dieldrin	0 / 4		No	Not Detected
Endosulfan I	0 / 4		No	Not Detected
Endosulfan II	0 / 4		No	Not Detected
Endosulfan sulfate	0 / 4		No	Not Detected
Endrin	0 / 4		No	Not Detected

TABLE 2-2

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection			Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Endrin Aldehyde	0	/	4		No	Not Detected
gamma-BHC (Lindane)	0	/	4		No	Not Detected
gamma-Chlordane	0	/	4		No	Not Detected
Heptachlor	0	/	4		No	Not Detected
Heptachlor epoxide	0	/	4		No	Not Detected
Methoxychlor	0	/	4		No	Not Detected
Toxaphene	0	/	4		No	Not Detected
Semivolatile Organics						
1,2,4,5-Tetrachloro-benzene	0	/	4		No	Not Detected
1,2,4-Trichlorobenzene	0	/	4		No	Not Detected
1,2-Dichlorobenzene	0	/	4		No	Not Detected
1,3-Dichlorobenzene	0	/	4		No	Not Detected
1,3-Dinitrobenzene	0	/	4		No	Not Detected
1,4-Dichlorobenzene	0	/	4		No	Not Detected
1-Chloronaphthalene	0	/	4		No	Not Detected
1-Naphthylamine	0	/	4		No	Not Detected
2,2'-oxybis(1-Chloropropane)	0	/	2		No	Not Detected
2,3,4,6-Tetrachlorophenol	0	/	4		No	Not Detected
2,4,5-Trichlorophenol	0	/	4		No	Not Detected
2,4,6-Trichlorophenol	0	/	4		No	Not Detected
2,4-Dichlorophenol	0	/	4		No	Not Detected
2,4-Dimethylphenol	0	/	4		No	Not Detected
2,4-Dinitrophenol	0	/	4		No	Not Detected
2,4-Dinitrotoluene	0	/	4		No	Not Detected
2,6-Dichlorophenol	0	/	4		No	Not Detected
2,6-Dinitrotoluene	0	/	4		No	Not Detected
2-Chloronaphthalene	0	/	4		No	Not Detected
2-Chlorophenol	0	/	4		No	Not Detected
2-Methylnaphthalene	0	/	4		No	Not Detected
2-Methylphenol	0	/	4		No	Not Detected
2-Naphthylamine	0	/	4		No	Not Detected
2-Nitrophenol	0	/	4		No	Not Detected
2-Picoline	0	/	4		No	Not Detected
3,3'-Dichlorobenzidine	0	/	4		No	Not Detected
3,3'-Dimethylbenzidine	0	/	4		No	Not Detected
3/4-Methylphenol	0	/	4		No	Not Detected
3-Methylcholanthrene	0	/	4		No	Not Detected
3-Nitroaniline	0	/	4		No	Not Detected
4,6-Dinitro-2-methylphenol	0	/	4		No	Not Detected
4-Aminobiphenyl	0	/	4		No	Not Detected
4-Bromophenyl phenyl ether	0	/	4		No	Not Detected
4-Chloro-3-methylphenol	0	/	4		No	Not Detected
4-Chloroaniline	0	/	4		No	Not Detected
4-Chlorophenyl phenyl ether	0	/	4		No	Not Detected
4-Dimethylaminoazobenzene	0	/	2		No	Not Detected
4-Nitroaniline	0	/	4		No	Not Detected

TABLE 2-2

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
4-Nitrophenol	0 / 4		No	Not Detected
7,12-Dimethylbenz(a)-anthracene	0 / 4		No	Not Detected
a,a-Dimethylphenethyl-amine	0 / 4		No	Not Detected
Acenaphthene	0 / 4		No	Not Detected
Acenaphthylene	0 / 4		No	Not Detected
Acetophenone	0 / 4		No	Not Detected
Aniline	0 / 4		No	Not Detected
Anthracene	0 / 4		No	Not Detected
Azobenzene	0 / 4		No	Not Detected
Benzidine	0 / 4		No	Not Detected
Benzo(a)anthracene	0 / 4		No	Not Detected
Benzo(a)pyrene	0 / 4		No	Not Detected
Benzo(b)fluoranthene	0 / 4		No	Not Detected
Benzo(g,h,i)perylene	0 / 4		No	Not Detected
Benzo(k)fluoranthene	0 / 4		No	Not Detected
Benzoic acid	0 / 4		No	Not Detected
Benzyl alcohol	0 / 4		No	Not Detected
bis(2-Chloroethoxy)methane	0 / 4		No	Not Detected
bis(2-Chloroethyl) ether	0 / 4		No	Not Detected
bis(2-Chloroisopropyl) ether	0 / 2		No	Not Detected
bis(2-Ethylhexyl)phthalate	1 / 4	0.0036	Yes	
Butyl benzyl phthalate	0 / 4		No	Not Detected
Chrysene	0 / 4		No	Not Detected
Dibenz(a,h)anthracene	0 / 4		No	Not Detected
Dibenz(a,j)acridine	0 / 4		No	Not Detected
Dibenzofuran	0 / 4		No	Not Detected
Diethyl phthalate	0 / 4		No	Not Detected
Dimethyl phthalate	0 / 4		No	Not Detected
Di-n-butyl phthalate	1 / 4	0.002	No	Below WQS
Di-n-octyl phthalate	0 / 4		No	Not Detected
Diphenylamine	0 / 4		No	Not Detected
Ethyl methanesulfonate	0 / 4		No	Not Detected
Fluoranthene	0 / 4		No	Not Detected
Fluorene	0 / 4		No	Not Detected
Hexachlorobenzene	0 / 4		No	Not Detected
Hexachlorobutadiene	0 / 4		No	Not Detected
Hexachlorocyclopentadiene	0 / 4		No	Not Detected
Hexachloroethane	0 / 4		No	Not Detected
Indeno(1,2,3-cd)pyrene	0 / 4		No	Not Detected
Isophorone	0 / 4		No	Not Detected
Methyl methanesulfonate	0 / 4		No	Not Detected
Naphthalene	0 / 4		No	Not Detected
Nitrobenzene	0 / 4		No	Not Detected
N-Nitroso-di-n-butylamine	0 / 4		No	Not Detected
N-Nitroso-di-n-propylamine	0 / 4		No	Not Detected
N-Nitrosodiphenylamine	0 / 4		No	Not Detected
N-Nitrosopiperidine	0 / 4		No	Not Detected

TABLE 2-2

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection			Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
p-Dimethylaminoazobenzene	0	/	4		No	Not Detected
Pentachlorobenzene	0	/	4		No	Not Detected
Pentachloronitrobenzene	0	/	4		No	Not Detected
Pentachlorophenol	0	/	4		No	Not Detected
Phenacetin	0	/	4		No	Not Detected
Phenanthrene	0	/	4		No	Not Detected
Phenol	0	/	4		No	Not Detected
Pronamide	0	/	4		No	Not Detected
Pyrene	0	/	4		No	Not Detected
Volatile Organics						
1,1,1,2-Tetrachloroethane	0	/	4		No	Not Detected
1,1,1-Trichloroethane	0	/	4		No	Not Detected
1,1,2,2-Tetrachloroethane	0	/	4		No	Not Detected
1,1,2-Trichloroethane	0	/	4		No	Not Detected
1,1-Dichloroethane	0	/	4		No	Not Detected
1,1-Dichloroethene	0	/	4		No	Not Detected
1,2,3-Trichloropropane	0	/	4		No	Not Detected
1,2-Dichloroethane	0	/	4		No	Not Detected
1,2-Dichloropropane	0	/	4		No	Not Detected
2-Butanone (MEK)	0	/	4		No	Not Detected
2-Chloroethyl vinyl ether	0	/	4		No	Not Detected
2-Hexanone	0	/	4		No	Not Detected
4-Methyl-2-pentanone (MIBK)	0	/	4		No	Not Detected
Acetone	0	/	4		No	Not Detected
Acrolein	0	/	4		No	Not Detected
Acrylonitrile	0	/	4		No	Not Detected
Benzene	0	/	4		No	Not Detected
Bromodichloromethane	0	/	4		No	Not Detected
Bromoform	0	/	4		No	Not Detected
Bromomethane	0	/	4		No	Not Detected
Carbon disulfide	0	/	4		No	Not Detected
Carbon tetrachloride	0	/	4		No	Not Detected
Chlorobenzene	0	/	4		No	Not Detected
Chloroethane	0	/	4		No	Not Detected
Chloroform	0	/	4		No	Not Detected
Chloromethane	0	/	4		No	Not Detected
cis-1,3-Dichloropropene	0	/	4		No	Not Detected
Dibromochloromethane	0	/	4		No	Not Detected
Dibromomethane	0	/	4		No	Not Detected
Dichlorodifluoromethane	0	/	4		No	Not Detected
Ethanol	0	/	4		No	Not Detected
Ethyl methacrylate	0	/	4		No	Not Detected
Ethylbenzene	0	/	4		No	Not Detected
Iodomethane	0	/	4		No	Not Detected
Methylene chloride	0	/	4		No	Not Detected
Styrene	0	/	4		No	Not Detected

TABLE 2-2

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Tetrachloroethene	0 / 4		No	Not Detected
Toluene	0 / 4		No	Not Detected
trans-1,2-Dichloroethene	0 / 4		No	Not Detected
trans-1,3-Dichloropropene	0 / 4		No	Not Detected
trans-1,4-Dichloro-2-butene	0 / 4		No	Not Detected
Trichloroethene	0 / 4		No	Not Detected
Trichlorofluoromethane	0 / 4		No	Not Detected
Vinyl acetate	0 / 4		No	Not Detected
Vinyl chloride	0 / 4		No	Not Detected
Xylenes (total)	0 / 4		No	Not Detected

Note:

a. Below WQS - see WQS comparison on Table 2-8
   Below Action Level - see WQS comparison on Table 2-8
   Below RDA - see RDA comparison on Table 2-14
   Below Background - see background comparison on Table 2-20

TABLE 2-3

CHEMICALS OF POTENTIAL CONCERN SCREENING ON-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection			Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Metals						
Aluminum	15	/	18	0.88	No	Below Background
Antimony	4	/	18	0.00069	No	Below WQS
Arsenic	0	/	18		No	Not Detected
Barium	18	/	18	0.52	No	Below Background
Beryllium	1	/	18	0.000068	Yes	
Cadmium	12	/	18	0.01	Yes	
Calcium	18	/	18	55.3	No	Below RDA
Chromium	18	/	18	0.025	Yes	
Cobalt	9	/	18	0.00045	Yes	
Copper	18	/	18	0.14	Yes	
Iron	13	/	18	1	No	Below Background
Lead	16	/	18	0.0091	No	Below Action Level
Magnesium	18	/	18	26.5	No	Below RDA
Manganese	18	/	18	0.053	No	Below Background
Mercury	0	/	18		No	Not Detected
Molybdenum	14	/	18	0.0036	Yes	
Nickel	18	/	18	0.015	No	Below WQS
Potassium	9	/	18	1.9	No	Below RDA
Selenium	9	/	18	0.0022	Yes	
Silver	0	/	18		No	Not Detected
Sodium	18	/	18	36.3	No	Below RDA
Thallium	8	/	18	0.000042	No	Below WQS
Vanadium	18	/	18	0.016	Yes	
Zinc	18	/	18	0.056	No	Below Background
PCBs/Pesticides						
4,4'-DDD	0	/	18		No	Not Detected
4,4'-DDE	0	/	18		No	Not Detected
4,4'-DDT	0	/	18		No	Not Detected
Aldrin	0	/	18		No	Not Detected
alpha-BHC	0	/	18		No	Not Detected
alpha-Chlordane	0	/	18		No	Not Detected
Aroclor 1016	0	/	18		No	Not Detected
Aroclor 1221	0	/	18		No	Not Detected
Aroclor 1232	0	/	18		No	Not Detected
Aroclor 1242	0	/	18		No	Not Detected
Aroclor 1248	0	/	18		No	Not Detected
Aroclor 1254	0	/	18		No	Not Detected
Aroclor 1260	0	/	18		No	Not Detected
beta-BHC	0	/	18		No	Not Detected
delta-BHC	0	/	18		No	Not Detected
Dieldrin	1	/	18	0.000029	Yes	
Endosulfan I	0	/	18		No	Not Detected
Endosulfan II	0	/	18		No	Not Detected
Endosulfan sulfate	0	/	18		No	Not Detected
Endrin	0	/	18		No	Not Detected
Endrin Aldehyde	0	/	18		No	Not Detected
gamma-BHC (Lindane)	0	/	18		No	Not Detected
gamma-Chlordane	0	/	18		No	Not Detected

TABLE 2-3

CHEMICALS OF POTENTIAL CONCERN SCREENING ON-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Heptachlor	1 / 18	0.000024	Yes	
Heptachlor epoxide	0 / 18		No	Not Detected
Methoxychlor	0 / 18		No	Not Detected
Toxaphene	0 / 18		No	Not Detected
Semivolatile Organics				
1,2,4,5-Tetrachloro-benzene	0 / 18		No	Not Detected
1,2,4-Trichlorobenzene	0 / 18		No	Not Detected
1,2-Dichlorobenzene	0 / 18		No	Not Detected
1,3-Dichlorobenzene	0 / 18		No	Not Detected
1,3-Dinitrobenzene	0 / 18		No	Not Detected
1,4-Dichlorobenzene	0 / 18		No	Not Detected
1-Chloronaphthalene	0 / 18		No	Not Detected
1-Naphthylamine	0 / 18		No	Not Detected
2,2'-oxybis(1-Chloropropane)	0 / 9		No	Not Detected
2,3,4,6-Tetrachlorophenol	0 / 18		No	Not Detected
2,4,5-Trichlorophenol	0 / 18		No	Not Detected
2,4,6-Trichlorophenol	0 / 18		No	Not Detected
2,4-Dichlorophenol	0 / 18		No	Not Detected
2,4-Dimethylphenol	0 / 18		No	Not Detected
2,4-Dinitrophenol	0 / 18		No	Not Detected
2,4-Dinitrotoluene	0 / 18		No	Not Detected
2,6-Dichlorophenol	0 / 18		No	Not Detected
2,6-Dinitrotoluene	0 / 18		No	Not Detected
2-Chloronaphthalene	0 / 18		No	Not Detected
2-Chlorophenol	0 / 18		No	Not Detected
2-Methylnaphthalene	0 / 18		No	Not Detected
2-Methylphenol	0 / 18		No	Not Detected
2-Naphthylamine	0 / 18		No	Not Detected
2-Nitrophenol	0 / 18		No	Not Detected
2-Picoline	0 / 18		No	Not Detected
3,3'-Dichlorobenzidine	0 / 18		No	Not Detected
3,3'-Dimethylbenzidine	0 / 18		No	Not Detected
3/4-Methylphenol	0 / 18		No	Not Detected
3-Methylcholanthrene	0 / 18		No	Not Detected
3-Nitroaniline	0 / 18		No	Not Detected
4,6-Dinitro-2-methylphenol	0 / 18		No	Not Detected
4-Aminobiphenyl	0 / 18		No	Not Detected
4-Bromophenyl phenyl ether	0 / 18		No	Not Detected
4-Chloro-3-methylphenol	0 / 18		No	Not Detected
4-Chloroaniline	0 / 18		No	Not Detected
4-Chlorophenyl phenyl ether	0 / 18		No	Not Detected
4-Dimethylaminoazobenzene	0 / 9		No	Not Detected
4-Nitroaniline	0 / 18		No	Not Detected
4-Nitrophenol	0 / 18		No	Not Detected
7,12-Dimethylbenz(a)-anthracene	0 / 18		No	Not Detected
a,a-Dimethylphenethyl-amine	0 / 18		No	Not Detected
Acenaphthene	0 / 18		No	Not Detected
Acenaphthylene	0 / 18		No	Not Detected
Acetophenone	0 / 18		No	Not Detected

TABLE 2-3

CHEMICALS OF POTENTIAL CONCERN SCREENING ON-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Aniline	0 / 18		No	Not Detected
Anthracene	0 / 18		No	Not Detected
Azobenzene	0 / 18		No	Not Detected
Benzidine	0 / 18		No	Not Detected
Benzo(a)anthracene	0 / 18		No	Not Detected
Benzo(a)pyrene	0 / 18		No	Not Detected
Benzo(b)fluoranthene	0 / 18		No	Not Detected
Benzo(g,h,i)perylene	0 / 18		No	Not Detected
Benzo(k)fluoranthene	0 / 18		No	Not Detected
Benzoic acid	0 / 18		No	Not Detected
Benzyl alcohol	0 / 18		No	Not Detected
bis(2-Chloroethoxy)methane	0 / 18		No	Not Detected
bis(2-Chloroethyl) ether	0 / 18		No	Not Detected
bis(2-Chloroisopropyl) ether	0 / 18		No	Not Detected
bis(2-Ethylhexyl)phthalate	3 / 18	0.14	Yes	
Butyl benzyl phthalate	0 / 18		No	Not Detected
Chrysene	0 / 18		No	Not Detected
Dibenz(a,h)anthracene	0 / 18		No	Not Detected
Dibenz(a,j)acridine	0 / 18		No	Not Detected
Dibenzofuran	0 / 18		No	Not Detected
Diethyl phthalate	0 / 18		No	Not Detected
Dimethyl phthalate	0 / 18		No	Not Detected
Di-n-butyl phthalate	0 / 18		No	Not Detected
Di-n-octyl phthalate	0 / 18		No	Not Detected
Diphenylamine	0 / 18		No	Not Detected
Ethyl methanesulfonate	0 / 18		No	Not Detected
Fluoranthene	0 / 18		No	Not Detected
Fluorene	0 / 18		No	Not Detected
Hexachlorobenzene	0 / 18		No	Not Detected
Hexachlorobutadiene	0 / 18		No	Not Detected
Hexachlorocyclopentadiene	0 / 18		No	Not Detected
Hexachloroethane	0 / 18		No	Not Detected
Indeno(1,2,3-cd)pyrene	0 / 18		No	Not Detected
Isophorone	0 / 18		No	Not Detected
Methyl methanesulfonate	0 / 18		No	Not Detected
Naphthalene	0 / 18		No	Not Detected
Nitrobenzene	0 / 18		No	Not Detected
N-Nitroso-di-n-butylamine	0 / 18		No	Not Detected
N-Nitroso-di-n-propylamine	0 / 18		No	Not Detected
N-Nitrosodiphenylamine	0 / 18		No	Not Detected
N-Nitrosopiperidine	0 / 18		No	Not Detected
p-Dimethylaminoazobenzene	0 / 18		No	Not Detected
Pentachlorobenzene	0 / 18		No	Not Detected
Pentachloronitrobenzene	0 / 18		No	Not Detected
Pentachlorophenol	0 / 18		No	Not Detected
Phenacetin	0 / 18		No	Not Detected
Phenanthrene	0 / 18		No	Not Detected
Phenol	0 / 18		No	Not Detected
Pronamide	0 / 18		No	Not Detected

TABLE 2-3

CHEMICALS OF POTENTIAL CONCERN SCREENING ON-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Pyrene	0 / 18		No	Not Detected
Volatile Organics				
1,1,1,2-Tetrachloroethane	0 / 18		No	Not Detected
1,1,1-Trichloroethane	0 / 18		No	Not Detected
1,1,2,2-Tetrachloroethane	0 / 18		No	Not Detected
1,1,2-Trichloroethane	0 / 18		No	Not Detected
1,1-Dichloroethane	0 / 18		No	Not Detected
1,1-Dichloroethene	0 / 18		No	Not Detected
1,2,3-Trichloropropane	0 / 18		No	Not Detected
1,2-Dichloroethane	0 / 18		No	Not Detected
1,2-Dichloropropane	0 / 18		No	Not Detected
2-Butanone (MEK)	0 / 18		No	Not Detected
2-Chloroethyl vinyl ether	0 / 18		No	Not Detected
2-Hexanone	0 / 18		No	Not Detected
4-Methyl-2-pentanone (MIBK)	0 / 18		No	Not Detected
Acetone	9 / 18	0.0038	Yes	
Acrolein	0 / 18		No	Not Detected
Acrylonitrile	0 / 18		No	Not Detected
Benzene	0 / 18		No	Not Detected
Bromodichloromethane	0 / 18		No	Not Detected
Bromoform	3 / 18	0.0014	No	Below WQS
Bromomethane	0 / 18		No	Not Detected
Carbon disulfide	0 / 18		No	Not Detected
Carbon tetrachloride	0 / 18		No	Not Detected
Chlorobenzene	0 / 18		No	Not Detected
Chloroethane	0 / 18		No	Not Detected
Chloroform	0 / 18		No	Not Detected
Chloromethane	0 / 18		No	Not Detected
cis-1,3-Dichloropropene	0 / 18		No	Not Detected
Dibromochloromethane	0 / 18		No	Not Detected
Dibromomethane	0 / 18		No	Not Detected
Dichlorodifluoromethane	0 / 18		No	Not Detected
Ethanol	0 / 18		No	Not Detected
Ethyl methacrylate	0 / 18		No	Not Detected
Ethylbenzene	0 / 18		No	Not Detected
Iodomethane	0 / 18		No	Not Detected
Methylene chloride	6 / 18	0.0022	No	Below WQS
Styrene	0 / 18		No	Not Detected
Tetrachloroethene	1 / 18	0.0015	Yes	
Toluene	0 / 18		No	Not Detected
trans-1,2-Dichloroethene	0 / 18		No	Not Detected
trans-1,3-Dichloropropene	0 / 18		No	Not Detected
trans-1,4-Dichloro-2-butene	0 / 18		No	Not Detected
Trichloroethene	0 / 18		No	Not Detected
Trichlorofluoromethane	0 / 18		No	Not Detected
Vinyl acetate	0 / 18		No	Not Detected
Vinyl chloride	0 / 18		No	Not Detected
Xylenes (total)	0 / 18		No	Not Detected

Note:

TABLE 2-3

CHEMICALS OF POTENTIAL CONCERN SCREENING
ON-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]

a. Below WQS - see WQS comparison on Table 2-9
Below Action Level - see WQS comparison on Table 2-9
Below RDA - see RDA comparison on Table 2-15
Below Background - see background comparison on Table 2-21

TABLE 2-4

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Metals				
Aluminum	4 / 4	0.5	No	Below Background
Antimony	3 / 4	0.0019	No	Below WQS
Arsenic	0 / 4		No	Not Detected
Barium	4 / 4	0.46	No	Below Background
Beryllium	0 / 4		No	Not Detected
Cadmium	4 / 4	0.0027	Yes	
Calcium	4 / 4	49.3	No	Below RDA
Chromium	4 / 4	0.012	Yes	
Cobalt	2 / 4	0.00027	Yes	
Copper	4 / 4	0.02	No	Below Background
Iron	4 / 4	1.2	No	Below Background
Lead	4 / 4	0.0038	No	Below Action Level
Magnesium	4 / 4	23	No	Below RDA
Manganese	4 / 4	0.12	No	Below Background
Mercury	1 / 4	0.000046	No	Below WQS
Molybdenum	4 / 4	0.0031	Yes	
Nickel	4 / 4	0.0067	No	Below WQS
Potassium	2 / 4	1.8	No	Below RDA
Selenium	2 / 4	0.0039	Yes	
Silver	0 / 4		No	Not Detected
Sodium	4 / 4	19.8	No	Below RDA
Thallium	2 / 4	0.000043	No	Below WQS
Vanadium	4 / 4	0.013	Yes	
Zinc	4 / 4	0.032	No	Below Background
PCBs/Pesticides				
4,4'-DDD	0 / 4		No	Not Detected
4,4'-DDE	0 / 4		No	Not Detected
4,4'-DDT	0 / 4		No	Not Detected
Aldrin	0 / 4		No	Not Detected
alpha-BHC	0 / 4		No	Not Detected
alpha-Chlordane	0 / 4		No	Not Detected
Aroclor 1016	0 / 4		No	Not Detected
Aroclor 1221	0 / 4		No	Not Detected
Aroclor 1232	0 / 4		No	Not Detected
Aroclor 1242	0 / 4		No	Not Detected
Aroclor 1248	0 / 4		No	Not Detected
Aroclor 1254	0 / 4		No	Not Detected
Aroclor 1260	0 / 4		No	Not Detected
beta-BHC	0 / 4		No	Not Detected
delta-BHC	0 / 4		No	Not Detected
Dieldrin	0 / 4		No	Not Detected
Endosulfan I	0 / 4		No	Not Detected
Endosulfan II	0 / 4		No	Not Detected
Endosulfan sulfate	0 / 4		No	Not Detected
Endrin	0 / 4		No	Not Detected

TABLE 2-4

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection			Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Endrin Aldehyde	0	/	4		No	Not Detected
gamma-BHC (Lindane)	0	/	4		No	Not Detected
gamma-Chlordane	0	/	4		No	Not Detected
Heptachlor	0	/	4		No	Not Detected
Heptachlor epoxide	0	/	4		No	Not Detected
Methoxychlor	0	/	4		No	Not Detected
Toxaphene	0	/	4		No	Not Detected
Semivolatile Organics						
1,2,4,5-Tetrachloro-benzene	0	/	4		No	Not Detected
1,2,4-Trichlorobenzene	0	/	4		No	Not Detected
1,2-Dichlorobenzene	0	/	4		No	Not Detected
1,3-Dichlorobenzene	0	/	4		No	Not Detected
1,3-Dinitrobenzene	0	/	4		No	Not Detected
1,4-Dichlorobenzene	0	/	4		No	Not Detected
1-Chloronaphthalene	0	/	4		No	Not Detected
1-Naphthylamine	0	/	4		No	Not Detected
2,2'-oxybis(1-Chloropropane)	0	/	2		No	Not Detected
2,3,4,6-Tetrachlorophenol	0	/	4		No	Not Detected
2,4,5-Trichlorophenol	0	/	4		No	Not Detected
2,4,6-Trichlorophenol	0	/	4		No	Not Detected
2,4-Dichlorophenol	0	/	4		No	Not Detected
2,4-Dimethylphenol	0	/	4		No	Not Detected
2,4-Dinitrophenol	0	/	4		No	Not Detected
2,4-Dinitrotoluene	0	/	4		No	Not Detected
2,6-Dichlorophenol	0	/	4		No	Not Detected
2,6-Dinitrotoluene	0	/	4		No	Not Detected
2-Chloronaphthalene	0	/	4		No	Not Detected
2-Chlorophenol	0	/	4		No	Not Detected
2-Methylnaphthalene	0	/	4		No	Not Detected
2-Methylphenol	0	/	4		No	Not Detected
2-Naphthylamine	0	/	4		No	Not Detected
2-Nitrophenol	0	/	4		No	Not Detected
2-Picoline	0	/	4		No	Not Detected
3,3'-Dichlorobenzidine	0	/	4		No	Not Detected
3,3'-Dimethylbenzidine	0	/	4		No	Not Detected
3/4-Methylphenol	0	/	4		No	Not Detected
3-Methylcholanthrene	0	/	4		No	Not Detected
3-Nitroaniline	0	/	4		No	Not Detected
4,6-Dinitro-2-methylphenol	0	/	4		No	Not Detected
4-Aminobiphenyl	0	/	4		No	Not Detected
4-Bromophenyl phenyl ether	0	/	4		No	Not Detected
4-Chloro-3-methylphenol	0	/	4		No	Not Detected
4-Chloroaniline	0	/	4		No	Not Detected
4-Chlorophenyl phenyl ether	0	/	4		No	Not Detected
4-Dimethylaminoazobenzene	0	/	2		No	Not Detected
4-Nitroaniline	0	/	4		No	Not Detected

TABLE 2-4

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
4-Nitrophenol	0 / 4		No	Not Detected
7,12-Dimethylbenz(a)-anthracene	0 / 4		No	Not Detected
a,a-Dimethylphenethyl-amine	0 / 4		No	Not Detected
Acenaphthene	0 / 4		No	Not Detected
Acenaphthylene	0 / 4		No	Not Detected
Acetophenone	0 / 4		No	Not Detected
Aniline	0 / 4		No	Not Detected
Anthracene	0 / 4		No	Not Detected
Azobenzene	0 / 4		No	Not Detected
Benzidine	0 / 4		No	Not Detected
Benzo(a)anthracene	0 / 4		No	Not Detected
Benzo(a)pyrene	0 / 4		No	Not Detected
Benzo(b)fluoranthene	0 / 4		No	Not Detected
Benzo(g,h,i)perylene	0 / 4		No	Not Detected
Benzo(k)fluoranthene	0 / 4		No	Not Detected
Benzoic acid	0 / 4		No	Not Detected
Benzyl alcohol	0 / 4		No	Not Detected
bis(2-Chloroethoxy)methane	0 / 4		No	Not Detected
bis(2-Chloroethyl) ether	0 / 4		No	Not Detected
bis(2-Chloroisopropyl) ether	0 / 2		No	Not Detected
bis(2-Ethylhexyl)phthalate	0 / 4		No	Not Detected
Butyl benzyl phthalate	0 / 4		No	Not Detected
Chrysene	0 / 4		No	Not Detected
Dibenz(a,h)anthracene	0 / 4		No	Not Detected
Dibenz(a,j)acridine	0 / 4		No	Not Detected
Dibenzofuran	0 / 4		No	Not Detected
Diethyl phthalate	0 / 4		No	Not Detected
Dimethyl phthalate	0 / 4		No	Not Detected
Di-n-butyl phthalate	0 / 4		No	Not Detected
Di-n-octyl phthalate	0 / 4		No	Not Detected
Diphenylamine	0 / 4		No	Not Detected
Ethyl methanesulfonate	0 / 4		No	Not Detected
Fluoranthene	0 / 4		No	Not Detected
Fluorene	0 / 4		No	Not Detected
Hexachlorobenzene	0 / 4		No	Not Detected
Hexachlorobutadiene	0 / 4		No	Not Detected
Hexachlorocyclopentadiene	0 / 4		No	Not Detected
Hexachloroethane	0 / 4		No	Not Detected
Indeno(1,2,3-cd)pyrene	0 / 4		No	Not Detected
Isophorone	0 / 4		No	Not Detected
Methyl methanesulfonate	0 / 4		No	Not Detected
Naphthalene	0 / 4		No	Not Detected
Nitrobenzene	0 / 4		No	Not Detected
N-Nitroso-di-n-butylamine	0 / 4		No	Not Detected
N-Nitroso-di-n-propylamine	0 / 4		No	Not Detected
N-Nitrosodiphenylamine	0 / 4		No	Not Detected
N-Nitrosopiperidine	0 / 4		No	Not Detected

TABLE 2-4

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
p-Dimethylaminoazobenzene	0 / 2		No	Not Detected
Pentachlorobenzene	0 / 4		No	Not Detected
Pentachloronitrobenzene	0 / 4		No	Not Detected
Pentachlorophenol	0 / 4		No	Not Detected
Phenacetin	0 / 4		No	Not Detected
Phenanthrene	0 / 4		No	Not Detected
Phenol	0 / 4		No	Not Detected
Pronamide	0 / 4		No	Not Detected
Pyrene	0 / 4		No	Not Detected
Volatile Organics				
1,1,1,2-Tetrachloroethane	0 / 4		No	Not Detected
1,1,1-Trichloroethane	0 / 4		No	Not Detected
1,1,2,2-Tetrachloroethane	0 / 4		No	Not Detected
1,1,2-Trichloroethane	0 / 4		No	Not Detected
1,1-Dichloroethane	0 / 4		No	Not Detected
1,1-Dichloroethene	0 / 4		No	Not Detected
1,2,3-Trichloropropane	0 / 4		No	Not Detected
1,2-Dichloroethane	0 / 4		No	Not Detected
1,2-Dichloropropane	0 / 4		No	Not Detected
2-Butanone (MEK)	0 / 4		No	Not Detected
2-Chloroethyl vinyl ether	0 / 4		No	Not Detected
2-Hexanone	0 / 4		No	Not Detected
4-Methyl-2-pentanone (MIBK)	0 / 4		No	Not Detected
Acetone	1 / 4	0.0032	Yes	
Acrolein	0 / 4		No	Not Detected
Acrylonitrile	0 / 4		No	Not Detected
Benzene	0 / 4		No	Not Detected
Bromodichloromethane	0 / 4		No	Not Detected
Bromoform	0 / 4		No	Not Detected
Bromomethane	0 / 4		No	Not Detected
Carbon disulfide	0 / 4		No	Not Detected
Carbon tetrachloride	0 / 4		No	Not Detected
Chlorobenzene	0 / 4		No	Not Detected
Chloroethane	0 / 4		No	Not Detected
Chloroform	0 / 4		No	Not Detected
Chloromethane	0 / 4		No	Not Detected
cis-1,3-Dichloropropene	0 / 4		No	Not Detected
Dibromochloromethane	0 / 4		No	Not Detected
Dibromomethane	0 / 4		No	Not Detected
Dichlorodifluoromethane	0 / 4		No	Not Detected
Ethanol	0 / 4		No	Not Detected
Ethyl methacrylate	0 / 4		No	Not Detected
Ethylbenzene	0 / 4		No	Not Detected
Iodomethane	0 / 4		No	Not Detected
Methylene chloride	0 / 4		No	Not Detected
Styrene	0 / 4		No	Not Detected

TABLE 2-4

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Frequency of Detection	Maximum Detected (mg/L)	COPC?	Reason For Exclusion[a]
Tetrachloroethene	0 / 4		No	Not Detected
Toluene	0 / 4		No	Not Detected
trans-1,2-Dichloroethene	0 / 4		No	Not Detected
trans-1,3-Dichloropropene	0 / 4		No	Not Detected
trans-1,4-Dichloro-2-butene	0 / 4		No	Not Detected
Trichloroethene	0 / 4		No	Not Detected
Trichlorofluoromethane	0 / 4		No	Not Detected
Vinyl acetate	0 / 4		No	Not Detected
Vinyl chloride	0 / 4		No	Not Detected
Xylenes (total)	0 / 4		No	Not Detected

Note:

a. Below WQS - see WQS comparison on Table 2-10
   Below Action Level - see WQS comparison on Table 2-10
   Below RDA - see RDA comparison on Table 2-16
   Below Background - see background comparison on Table 2-22

TABLE 2-5

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection	Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
Metals				
Aluminum	2 / 4	4220	No	Below RBC
Antimony	0 / 4		No	Not Detected
Arsenic	4 / 4	12.2	Yes	
Barium	4 / 4	790	No	Below Background
Beryllium	4 / 4	0.53	No	Below RBC
Cadmium	4 / 4	12.1	Yes	
Calcium	2 / 4	57100	No	Below RDA
Chromium	4 / 4	90.6	Yes	
Cobalt	4 / 4	9.6	No	Below RBC
Copper	4 / 4	19.4	No	Below RBC
Iron	4 / 4	15000	No	Below Background
Lead	4 / 4	36.2	No	Below RBC
Magnesium	4 / 4	17900	No	Below RDA
Manganese	4 / 4	637	No	Below Background
Mercury	0 / 4		No	Not Detected
Molybdenum	2 / 4	4.2	No	Below RBC
Nickel	4 / 4	78.7	No	Below RBC
Potassium	3 / 4	891	No	Below RDA
Selenium	1 / 4	3.1	No	Below RBC
Silver	3 / 4	8.6	No	Below RBC
Sodium	0 / 4		No	Not Detected
Thallium	3 / 4	43.1	Yes	
Vanadium	4 / 4	26.7	No	Below RBC
Zinc	4 / 4	103	No	Below RBC
PCBs/Pesticides				
4,4'-DDD	0 / 4		No	Not Detected
4,4'-DDE	0 / 4		No	Not Detected
4,4'-DDT	0 / 4		No	Not Detected
Aldrin	0 / 4		No	Not Detected
alpha-BHC	0 / 4		No	Not Detected
alpha-Chlordane	0 / 4		No	Not Detected
Aroclor 1016	0 / 4		No	Not Detected
Aroclor 1221	0 / 4		No	Not Detected
Aroclor 1232	0 / 4		No	Not Detected
Aroclor 1242	0 / 4		No	Not Detected
Aroclor 1248	0 / 4		No	Not Detected
Aroclor 1254	4 / 4	4.6	Yes	
Aroclor 1260	0 / 4		No	Not Detected
beta-BHC	0 / 4		No	Not Detected
delta-BHC	0 / 4		No	Not Detected
Dieldrin	0 / 4		No	Not Detected
Endosulfan I	0 / 4		No	Not Detected
Endosulfan II	0 / 4		No	Not Detected
Endosulfan sulfate	0 / 4		No	Not Detected
Endrin	0 / 4		No	Not Detected

TABLE 2-5

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection			Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
Endrin Aldehyde	0	/	4		No	Not Detected
gamma-BHC (Lindane)	0	/	4		No	Not Detected
gamma-Chlordane	0	/	4		No	Not Detected
Heptachlor	0	/	4		No	Not Detected
Heptachlor epoxide	0	/	4		No	Not Detected
Methoxychlor	0	/	4		No	Not Detected
Toxaphene	0	/	4		No	Not Detected
Semivolatile Organics						
1,2,4,5-Tetrachloro-benzene	0	/	4		No	Not Detected
1,2,4-Trichlorobenzene	0	/	4		No	Not Detected
1,2-Dichlorobenzene	0	/	4		No	Not Detected
1,3-Dichlorobenzene	0	/	4		No	Not Detected
1,3-Dinitrobenzene	0	/	4		No	Not Detected
1,4-Dichlorobenzene	0	/	4		No	Not Detected
1-Chloronaphthalene	0	/	4		No	Not Detected
1-Naphthylamine	0	/	4		No	Not Detected
2,2'-oxybis(1-Chloropropane)	0	/	2		No	Not Detected
2,3,4,6-Tetrachlorophenol	0	/	4		No	Not Detected
2,4,5-Trichlorophenol	0	/	4		No	Not Detected
2,4,6-Trichlorophenol	0	/	4		No	Not Detected
2,4-Dichlorophenol	0	/	4		No	Not Detected
2,4-Dimethylphenol	0	/	4		No	Not Detected
2,4-Dinitrophenol	0	/	4		No	Not Detected
2,4-Dinitrotoluene	0	/	4		No	Not Detected
2,6-Dichlorophenol	0	/	4		No	Not Detected
2,6-Dinitrotoluene	0	/	4		No	Not Detected
2-Chloronaphthalene	0	/	4		No	Not Detected
2-Chlorophenol	0	/	4		No	Not Detected
2-Methylnaphthalene	0	/	4		No	Not Detected
2-Methylphenol	0	/	4		No	Not Detected
2-Naphthylamine	0	/	4		No	Not Detected
2-Nitrophenol	0	/	4		No	Not Detected
2-Picoline	0	/	4		No	Not Detected
3,3'-Dichlorobenzidine	0	/	4		No	Not Detected
3,3'-Dimethylbenzidine	0	/	4		No	Not Detected
3/4-Methylphenol	0	/	4		No	Not Detected
3-Methylcholanthrene	0	/	4		No	Not Detected
3-Nitroaniline	0	/	4		No	Not Detected
4,6-Dinitro-2-methylphenol	0	/	4		No	Not Detected
4-Aminobiphenyl	0	/	4		No	Not Detected
4-Bromophenyl phenyl ether	0	/	4		No	Not Detected
4-Chloro-3-methylphenol	0	/	4		No	Not Detected
4-Chloroaniline	0	/	4		No	Not Detected
4-Chlorophenyl phenyl ether	0	/	4		No	Not Detected
4-Dimethylaminoazobenzene	0	/	2		No	Not Detected
4-Nitroaniline	0	/	4		No	Not Detected

TABLE 2-5

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection			Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
4-Nitrophenol	0	/	4		No	Not Detected
7,12-Dimethylbenz(a)-anthracene	0	/	4		No	Not Detected
a,a-Dimethylphenethyl-amine	0	/	4		No	Not Detected
Acenaphthene	1	/	4	0.093	No	Below RBC
Acenaphthylene	0	/	4		No	Not Detected
Acetophenone	0	/	4		No	Not Detected
Aniline	0	/	4		No	Not Detected
Anthracene	1	/	4	0.29	No	Below RBC
Azobenzene	0	/	4		No	Not Detected
Benzidine	1	/	4	0.089	Yes	
Benzo(a)anthracene	2	/	4	0.57	No	Below RBC
Benzo(a)pyrene	3	/	4	0.58	Yes	
Benzo(b)fluoranthene	2	/	4	0.4	No	Below RBC
Benzo(g,h,i)perylene	2	/	4	0.62	No	Below RBC
Benzo(k)fluoranthene	3	/	4	0.58	No	Below RBC
Benzoic acid	0	/	4		No	Not Detected
Benzyl alcohol	0	/	4		No	Not Detected
bis(2-Chloroethoxy)methane	0	/	4		No	Not Detected
bis(2-Chloroethyl) ether	0	/	4		No	Not Detected
bis(2-Chloroisopropyl) ether	0	/	2		No	Not Detected
bis(2-Ethylhexyl)phthalate	4	/	4	0.38	No	Below RBC
Butyl benzyl phthalate	1	/	4	0.068	No	Below RBC
Chrysene	3	/	4	0.68	No	Below RBC
Dibenz(a,h)anthracene	1	/	4	0.18	Yes	
Dibenz(a,j)acridine	0	/	4		No	Not Detected
Dibenzofuran	0	/	4		No	Not Detected
Diethyl phthalate	0	/	4		No	Not Detected
Dimethyl phthalate	0	/	4		No	Not Detected
Di-n-butyl phthalate	0	/	4		No	Not Detected
Di-n-octyl phthalate	0	/	4		No	Not Detected
Diphenylamine	0	/	4		No	Not Detected
Ethyl methanesulfonate	0	/	4		No	Not Detected
Fluoranthene	3	/	4	1.6	No	Below RBC
Fluorene	1	/	4	0.11	No	Below RBC
Hexachlorobenzene	0	/	4		No	Not Detected
Hexachlorobutadiene	0	/	4		No	Not Detected
Hexachlorocyclopentadiene	0	/	4		No	Not Detected
Hexachloroethane	0	/	4		No	Not Detected
Indeno(1,2,3-cd)pyrene	2	/	4	0.49	No	Below RBC
Isophorone	0	/	4		No	Not Detected
Methyl methanesulfonate	0	/	4		No	Not Detected
Naphthalene	0	/	4		No	Not Detected
Nitrobenzene	0	/	4		No	Not Detected
N-Nitroso-di-n-butylamine	0	/	4		No	Not Detected
N-Nitroso-di-n-propylamine	0	/	4		No	Not Detected
N-Nitrosodiphenylamine	0	/	4		No	Not Detected
N-Nitrosopiperidine	0	/	4		No	Not Detected

TABLE 2-5

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection			Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
p-Dimethylaminoazobenzene	0	/	4		No	Not Detected
Pentachlorobenzene	0	/	4		No	Not Detected
Pentachloronitrobenzene	0	/	4		No	Not Detected
Pentachlorophenol	0	/	4		No	Not Detected
Phenacetin	0	/	4		No	Not Detected
Phenanthrene	2	/	4	0.97	No	Below RBC
Phenol	0	/	4		No	Not Detected
Pronamide	0	/	4		No	Not Detected
Pyrene	3	/	4	1.2	No	Below RBC
Volatile Organics						
1,1,1,2-Tetrachloroethane	0	/	4		No	Not Detected
1,1,1-Trichloroethane	0	/	4		No	Not Detected
1,1,2,2-Tetrachloroethane	0	/	4		No	Not Detected
1,1,2-Trichloroethane	0	/	4		No	Not Detected
1,1-Dichloroethane	0	/	4		No	Not Detected
1,1-Dichloroethene	0	/	4		No	Not Detected
1,2,3-Trichloropropane	0	/	4		No	Not Detected
1,2-Dichloroethane	0	/	4		No	Not Detected
1,2-Dichloropropane	0	/	4		No	Not Detected
2-Butanone (MEK)	0	/	4		No	Not Detected
2-Chloroethyl vinyl ether	0	/	4		No	Not Detected
2-Hexanone	0	/	4		No	Not Detected
4-Methyl-2-pentanone (MIBK)	0	/	4		No	Not Detected
Acetone	1	/	4	0.0051	No	Below RBC
Acrolein	0	/	4		No	Not Detected
Acrylonitrile	0	/	4		No	Not Detected
Benzene	0	/	4		No	Not Detected
Bromodichloromethane	0	/	4		No	Not Detected
Bromoform	0	/	4		No	Not Detected
Bromomethane	0	/	4		No	Not Detected
Carbon disulfide	0	/	4		No	Not Detected
Carbon tetrachloride	0	/	4		No	Not Detected
Chlorobenzene	0	/	4		No	Not Detected
Chloroethane	0	/	4		No	Not Detected
Chloroform	0	/	4		No	Not Detected
Chloromethane	0	/	4		No	Not Detected
cis-1,3-Dichloropropene	0	/	4		No	Not Detected
Dibromochloromethane	0	/	4		No	Not Detected
Dibromomethane	0	/	4		No	Not Detected
Dichlorodifluoromethane	0	/	4		No	Not Detected
Ethanol	0	/	4		No	Not Detected
Ethyl methacrylate	0	/	4		No	Not Detected
Ethylbenzene	0	/	4		No	Not Detected
Iodomethane	0	/	4		No	Not Detected
Methylene chloride	0	/	4		No	Not Detected
Styrene	0	/	4		No	Not Detected

TABLE 2-5

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE WEST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection	Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
Tetrachloroethene	0 / 4		No	Not Detected
Toluene	0 / 4		No	Not Detected
trans-1,2-Dichloroethene	0 / 4		No	Not Detected
trans-1,3-Dichloropropene	0 / 4		No	Not Detected
trans-1,4-Dichloro-2-butene	0 / 4		No	Not Detected
Trichloroethene	0 / 4		No	Not Detected
Trichlorofluoromethane	0 / 4		No	Not Detected
Vinyl acetate	0 / 4		No	Not Detected
Vinyl chloride	0 / 4		No	Not Detected
Xylenes (total)	0 / 4		No	Not Detected

Note:

a. Below RBC - see RBC comparison on Table 2-11
   Below RDA - see RDA comparison on Table 2-17
   Below Background - see background comparison on Table 2-23

TABLE 2-6

CHEMICALS OF POTENTIAL CONCERN SCREENING
ON-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection	Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
Endrin Aldehyde	0 / 34		No	Not Detected
gamma-BHC (Lindane)	0 / 34		No	Not Detected
gamma-Chlordane	1 / 34	0.025	No	Below RBC
Heptachlor	0 / 34		No	Not Detected
Heptachlor epoxide	0 / 34		No	Not Detected
Methoxychlor	0 / 34		No	Not Detected
Toxaphene	0 / 34		No	Not Detected
Semivolatile Organics				
1,2,4,5-Tetrachloro-benzene	0 / 34		No	Not Detected
1,2,4-Trichlorobenzene	0 / 34		No	Not Detected
1,2-Dichlorobenzene	6 / 34	11	No	Below RBC
1,3-Dichlorobenzene	2 / 34	1.1	No	Below RBC
1,3-Dinitrobenzene	0 / 34		No	Not Detected
1,4-Dichlorobenzene	5 / 34	6.3	No	Below RBC
1-Chloronaphthalene	0 / 34		No	Not Detected
1-Naphthylamine	0 / 34		No	Not Detected
2,2'-oxybis(1-Chloropropane)	0 / 17		No	Not Detected
2,3,4,6-Tetrachlorophenol	0 / 34		No	Not Detected
2,4,5-Trichlorophenol	0 / 34		No	Not Detected
2,4,6-Trichlorophenol	0 / 34		No	Not Detected
2,4-Dichlorophenol	0 / 34		No	Not Detected
2,4-Dimethylphenol	1 / 34	0.062	No	Below RBC
2,4-Dinitrophenol	0 / 34		No	Not Detected
2,4-Dinitrotoluene	0 / 34		No	Not Detected
2,6-Dichlorophenol	0 / 34		No	Not Detected
2,6-Dinitrotoluene	0 / 34		No	Not Detected
2-Chloronaphthalene	7 / 34	0.71	No	Below RBC
2-Chlorophenol	0 / 34		No	Not Detected
2-Methylnaphthalene	8 / 34	1.6	No	Below RBC
2-Methylphenol	1 / 34	0.083	No	Below RBC
2-Naphthylamine	0 / 34		No	Not Detected
2-Nitrophenol	0 / 34		No	Not Detected
2-Picoline	0 / 34		No	Not Detected
3,3'-Dichlorobenzidine	0 / 34		No	Not Detected
3,3'-Dimethylbenzidine	0 / 34		No	Not Detected
3/4-Methylphenol	0 / 34		No	Not Detected
3-Methylcholanthrene	0 / 34		No	Not Detected
3-Nitroaniline	0 / 34		No	Not Detected
4,6-Dinitro-2-methylphenol	0 / 34		No	Not Detected
4-Aminobiphenyl	0 / 34		No	Not Detected
4-Bromophenyl phenyl ether	0 / 34		No	Not Detected
4-Chloro-3-methylphenol	0 / 34		No	Not Detected
4-Chloroaniline	0 / 34		No	Not Detected
4-Chlorophenyl phenyl ether	0 / 34		No	Not Detected
4-Dimethylaminoazobenzene	0 / 17		No	Not Detected
4-Nitroaniline	0 / 34		No	Not Detected

TABLE 2-6

CHEMICALS OF POTENTIAL CONCERN SCREENING ON-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection			Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
4-Nitrophenol	0	/	34		No	Not Detected
7,12-Dimethylbenz(a)-anthracene	0	/	34		No	Not Detected
a,a-Dimethylphenethyl-amine	0	/	34		No	Not Detected
Acenaphthene	17	/	34	2.4	No	Below RBC
Acenaphthylene	4	/	34	0.09	No	Below RBC
Acetophenone	0	/	34		No	Not Detected
Aniline	0	/	34		No	Not Detected
Anthracene	25	/	34	12	No	Below RBC
Azobenzene	0	/	34		No	Not Detected
Benzidine	1	/	34	0.094	Yes	
Benzo(a)anthracene	29	/	34	46	Yes	
Benzo(a)pyrene	29	/	34	63	Yes	
Benzo(b)fluoranthene	29	/	34	55	Yes	
Benzo(g,h,i)perylene	29	/	34	60	No	Below RBC
Benzo(k)fluoranthene	28	/	34	59	Yes	
Benzoic acid	0	/	34		No	Not Detected
Benzyl alcohol	0	/	34		No	Not Detected
bis(2-Chloroethoxy)methane	0	/	34		No	Not Detected
bis(2-Chloroethyl) ether	0	/	34		No	Not Detected
bis(2-Chloroisopropyl) ether	0	/	17		No	Not Detected
bis(2-Ethylhexyl)phthalate	31	/	34	16	No	Below RBC
Butyl benzyl phthalate	0	/	34		No	Not Detected
Chrysene	29	/	34	66	No	Below RBC
Dibenz(a,h)anthracene	20	/	34	15	Yes	
Dibenz(a,j)acridine	0	/	34		No	Not Detected
Dibenzofuran	11	/	34	1.4	No	Below RBC
Diethyl phthalate	0	/	34		No	Not Detected
Dimethyl phthalate	0	/	34		No	Not Detected
Di-n-butyl phthalate	1	/	34	0.053	No	Below RBC
Di-n-octyl phthalate	2	/	34	0.51	No	Below RBC
Diphenylamine	0	/	34		No	Not Detected
Ethyl methanesulfonate	0	/	34		No	Not Detected
Fluoranthene	33	/	34	160	No	Below RBC
Fluorene	19	/	34	4.2	No	Below RBC
Hexachlorobenzene	0	/	34		No	Not Detected
Hexachlorobutadiene	0	/	34		No	Not Detected
Hexachlorocyclopentadiene	0	/	34		No	Not Detected
Hexachloroethane	0	/	34		No	Not Detected
Indeno(1,2,3-cd)pyrene	29	/	34	49	Yes	
Isophorone	0	/	34		No	Not Detected
Methyl methanesulfonate	0	/	34		No	Not Detected
Naphthalene	19	/	34	9.4	No	Below RBC
Nitrobenzene	0	/	34		No	Not Detected
N-Nitroso-di-n-butylamine	0	/	34		No	Not Detected
N-Nitroso-di-n-propylamine	0	/	34		No	Not Detected
N-Nitrosodiphenylamine	0	/	34		No	Not Detected
N-Nitrosopiperidine	0	/	34		No	Not Detected

TABLE 2-6

CHEMICALS OF POTENTIAL CONCERN SCREENING
ON-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection			Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
p-Dimethylaminoazobenzene	0	/	34		No	Not Detected
Pentachlorobenzene	0	/	34		No	Not Detected
Pentachloronitrobenzene	0	/	34		No	Not Detected
Pentachlorophenol	0	/	34		No	Not Detected
Phenacetin	0	/	34		No	Not Detected
Phenanthrene	30	/	34	70	No	Below RBC
Phenol	1	/	34	0.046	No	Below RBC
Pronamide	0	/	34		No	Not Detected
Pyrene	32	/	34	120	No	Below RBC
Volatile Organics						
1,1,1,2-Tetrachloroethane	0	/	34		No	Not Detected
1,1,1-Trichloroethane	0	/	34		No	Not Detected
1,1,2,2-Tetrachloroethane	0	/	34		No	Not Detected
1,1,2-Trichloroethane	0	/	34		No	Not Detected
1,1-Dichloroethane	0	/	34		No	Not Detected
1,1-Dichloroethene	0	/	34		No	Not Detected
1,2,3-Trichloropropane	0	/	34		No	Not Detected
1,2-Dichloroethane	0	/	34		No	Not Detected
1,2-Dichloropropane	0	/	34		No	Not Detected
2-Butanone (MEK)	7	/	34	0.062	No	Below RBC
2-Chloroethyl vinyl ether	0	/	34		No	Not Detected
2-Hexanone	0	/	34		No	Not Detected
4-Methyl-2-pentanone (MIBK)	0	/	34		No	Not Detected
Acetone	23	/	34	0.21	No	Below RBC
Acrolein	0	/	34		No	Not Detected
Acrylonitrile	1	/	34	0.014	No	Below RBC
Benzene	0	/	34		No	Not Detected
Bromodichloromethane	0	/	34		No	Not Detected
Bromoform	0	/	34		No	Not Detected
Bromomethane	0	/	34		No	Not Detected
Carbon disulfide	5	/	34	0.01	No	Below RBC
Carbon tetrachloride	0	/	34		No	Not Detected
Chlorobenzene	13	/	34	20	No	Below RBC
Chloroethane	0	/	34		No	Not Detected
Chloroform	0	/	34		No	Not Detected
Chloromethane	0	/	34		No	Not Detected
cis-1,3-Dichloropropene	0	/	34		No	Not Detected
Dibromochloromethane	0	/	34		No	Not Detected
Dibromomethane	0	/	34		No	Not Detected
Dichlorodifluoromethane	2	/	34	0.0043	No	Below RBC
Ethanol	0	/	34		No	Not Detected
Ethyl methacrylate	0	/	34		No	Not Detected
Ethylbenzene	4	/	34	0.06	No	Below RBC
Iodomethane	0	/	34		No	Not Detected
Methylene chloride	6	/	34	0.0069	No	Below RBC
Styrene	0	/	34		No	Not Detected

TABLE 2-6

CHEMICALS OF POTENTIAL CONCERN SCREENING
ON-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection	Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
Tetrachloroethene	1 / 34	0.0022	No	Below RBC
Toluene	2 / 34	0.0025	No	Below RBC
trans-1,2-Dichloroethene	0 / 34		No	Not Detected
trans-1,3-Dichloropropene	0 / 34		No	Not Detected
trans-1,4-Dichloro-2-butene	0 / 34		No	Not Detected
Trichloroethene	0 / 34		No	Not Detected
Trichlorofluoromethane	2 / 34	0.0035	No	Below RBC
Vinyl acetate	0 / 34		No	Not Detected
Vinyl chloride	0 / 34		No	Not Detected
Xylenes (total)	5 / 34	0.0094	No	Below RBC

Note:

a. Below RBC - see RBC comparison on Table 2-12
   Below RDA - see RDA comparison on Table 2-18
   Below Background - see background comparison on Table 2-24

TABLE 2-7

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection	Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
Metals				
Aluminum	10 / 10	7950	No	Below Background
Antimony	1 / 10	2.9	No	Below RBC
Arsenic	10 / 10	2.8	No	Below Background
Barium	10 / 10	4550	Yes	
Beryllium	10 / 10	0.59	No	Below RBC
Cadmium	7 / 10	52	Yes	
Calcium	10 / 10	40300	No	Below RDA
Chromium	10 / 10	269	Yes	
Cobalt	10 / 10	5.7	No	Below RBC
Copper	10 / 10	28.6	No	Below RBC
Iron	7 / 10	11400	No	Below Background
Lead	6 / 10	21.7	No	Below RBC
Magnesium	10 / 10	14900	No	Below RDA
Manganese	10 / 10	926	No	Below Background
Mercury	2 / 10	0.028	No	Below RBC
Molybdenum	3 / 10	3.3	No	Below RBC
Nickel	10 / 10	74.7	No	Below RBC
Potassium	9 / 10	1080	No	Below RDA
Selenium	5 / 10	1.2	No	Below RBC
Silver	3 / 10	8	No	Below RBC
Sodium	0 / 10		No	Not Detected
Thallium	0 / 10		No	Not Detected
Vanadium	10 / 10	20.8	No	Below RBC
Zinc	7 / 10	33.3	No	Below RBC
PCBs/Pesticides				
4,4'-DDD	0 / 10		No	Not Detected
4,4'-DDE	0 / 10		No	Not Detected
4,4'-DDT	0 / 10		No	Not Detected
Aldrin	0 / 10		No	Not Detected
alpha-BHC	0 / 10		No	Not Detected
alpha-Chlordane	0 / 10		No	Not Detected
Aroclor 1016	0 / 10		No	Not Detected
Aroclor 1221	0 / 10		No	Not Detected
Aroclor 1232	0 / 10		No	Not Detected
Aroclor 1242	0 / 10		No	Not Detected
Aroclor 1248	0 / 10		No	Not Detected
Aroclor 1254	1 / 10	0.025	No	Below RBC
Aroclor 1260	0 / 10		No	Not Detected
beta-BHC	0 / 10		No	Not Detected
delta-BHC	0 / 10		No	Not Detected
Dieldrin	0 / 10		No	Not Detected
Endosulfan I	0 / 10		No	Not Detected
Endosulfan II	0 / 10		No	Not Detected
Endosulfan sulfate	0 / 10		No	Not Detected
Endrin	0 / 10		No	Not Detected

TABLE 2-7

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection			Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
Endrin Aldehyde	0	/	10		No	Not Detected
gamma-BHC (Lindane)	0	/	10		No	Not Detected
gamma-Chlordane	0	/	10		No	Not Detected
Heptachlor	0	/	10		No	Not Detected
Heptachlor epoxide	0	/	10		No	Not Detected
Methoxychlor	0	/	10		No	Not Detected
Toxaphene	0	/	10		No	Not Detected
Semivolatile Organics						
1,2,4,5-Tetrachloro-benzene	0	/	10		No	Not Detected
1,2,4-Trichlorobenzene	0	/	10		No	Not Detected
1,2-Dichlorobenzene	0	/	10		No	Not Detected
1,3-Dichlorobenzene	0	/	10		No	Not Detected
1,3-Dinitrobenzene	0	/	10		No	Not Detected
1,4-Dichlorobenzene	0	/	10		No	Not Detected
1-Chloronaphthalene	0	/	10		No	Not Detected
1-Naphthylamine	0	/	10		No	Not Detected
2,2'-oxybis(1-Chloropropane)	0	/	5		No	Not Detected
2,3,4,6-Tetrachlorophenol	0	/	10		No	Not Detected
2,4,5-Trichlorophenol	0	/	10		No	Not Detected
2,4,6-Trichlorophenol	0	/	10		No	Not Detected
2,4-Dichlorophenol	0	/	10		No	Not Detected
2,4-Dimethylphenol	0	/	10		No	Not Detected
2,4-Dinitrophenol	0	/	10		No	Not Detected
2,4-Dinitrotoluene	0	/	10		No	Not Detected
2,6-Dichlorophenol	0	/	10		No	Not Detected
2,6-Dinitrotoluene	0	/	10		No	Not Detected
2-Chloronaphthalene	0	/	10		No	Not Detected
2-Chlorophenol	0	/	10		No	Not Detected
2-Methylnaphthalene	0	/	10		No	Not Detected
2-Methylphenol	0	/	10		No	Not Detected
2-Naphthylamine	0	/	10		No	Not Detected
2-Nitrophenol	0	/	10		No	Not Detected
2-Picoline	0	/	10		No	Not Detected
3,3'-Dichlorobenzidine	0	/	10		No	Not Detected
3,3'-Dimethylbenzidine	0	/	10		No	Not Detected
3/4-Methylphenol	0	/	10		No	Not Detected
3-Methylcholanthrene	0	/	10		No	Not Detected
3-Nitroaniline	0	/	10		No	Not Detected
4,6-Dinitro-2-methylphenol	0	/	10		No	Not Detected
4-Aminobiphenyl	0	/	10		No	Not Detected
4-Bromophenyl phenyl ether	0	/	10		No	Not Detected
4-Chloro-3-methylphenol	0	/	10		No	Not Detected
4-Chloroaniline	0	/	10		No	Not Detected
4-Chlorophenyl phenyl ether	0	/	10		No	Not Detected
4-Dimethylaminoazobenzene	0	/	5		No	Not Detected
4-Nitroaniline	0	/	10		No	Not Detected

TABLE 2-7

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection			Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
4-Nitrophenol	0	/	10		No	Not Detected
7,12-Dimethylbenz(a)-anthracene	0	/	10		No	Not Detected
a,a-Dimethylphenethyl-amine	0	/	10		No	Not Detected
Acenaphthene	0	/	10		No	Not Detected
Acenaphthylene	0	/	10		No	Not Detected
Acetophenone	0	/	10		No	Not Detected
Aniline	0	/	10		No	Not Detected
Anthracene	0	/	10		No	Not Detected
Azobenzene	0	/	10		No	Not Detected
Benzidine	0	/	10		No	Not Detected
Benzo(a)anthracene	1	/	10	0.066	No	Below RBC
Benzo(a)pyrene	2	/	10	0.15	Yes	
Benzo(b)fluoranthene	1	/	10	0.088	No	Below RBC
Benzo(g,h,i)perylene	1	/	10	0.074	No	Below RBC
Benzo(k)fluoranthene	1	/	10	0.095	No	Below RBC
Benzoic acid	0	/	10		No	Not Detected
Benzyl alcohol	0	/	10		No	Not Detected
bis(2-Chloroethoxy)methane	0	/	10		No	Not Detected
bis(2-Chloroethyl) ether	0	/	10		No	Not Detected
bis(2-Chloroisopropyl) ether	0	/	5		No	Not Detected
bis(2-Ethylhexyl)phthalate	2	/	10	0.36	No	Below RBC
Butyl benzyl phthalate	0	/	10		No	Not Detected
Chrysene	1	/	10	0.12	No	Below RBC
Dibenz(a,h)anthracene	0	/	10		No	Not Detected
Dibenz(a,j)acridine	0	/	10		No	Not Detected
Dibenzofuran	0	/	10		No	Not Detected
Diethyl phthalate	0	/	10		No	Not Detected
Dimethyl phthalate	0	/	10		No	Not Detected
Di-n-butyl phthalate	0	/	10		No	Not Detected
Di-n-octyl phthalate	0	/	10		No	Not Detected
Diphenylamine	0	/	10		No	Not Detected
Ethyl methanesulfonate	0	/	10		No	Not Detected
Fluoranthene	2	/	10	0.35	No	Below RBC
Fluorene	0	/	10		No	Not Detected
Hexachlorobenzene	0	/	10		No	Not Detected
Hexachlorobutadiene	0	/	10		No	Not Detected
Hexachlorocyclopentadiene	0	/	10		No	Not Detected
Hexachloroethane	0	/	10		No	Not Detected
Indeno(1,2,3-cd)pyrene	1	/	10	0.066	No	Below RBC
Isophorone	0	/	10		No	Not Detected
Methyl methanesulfonate	0	/	10		No	Not Detected
Naphthalene	1	/	10	0.044	No	Below RBC
Nitrobenzene	0	/	10		No	Not Detected
N-Nitroso-di-n-butylamine	0	/	10		No	Not Detected
N-Nitroso-di-n-propylamine	0	/	10		No	Not Detected
N-Nitrosodiphenylamine	0	/	10		No	Not Detected
N-Nitrosopiperidine	0	/	10		No	Not Detected

TABLE 2-7

CHEMICALS OF POTENTIAL CONCERN SCREENING OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection	Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
p-Dimethylaminoazobenzene	0 / 10		No	Not Detected
Pentachlorobenzene	0 / 10		No	Not Detected
Pentachloronitrobenzene	0 / 10		No	Not Detected
Pentachlorophenol	0 / 10		No	Not Detected
Phenacetin	0 / 10		No	Not Detected
Phenanthrene	1 / 10	0.15	No	Below RBC
Phenol	0 / 10		No	Not Detected
Pronamide	0 / 10		No	Not Detected
Pyrene	1 / 10	0.19	No	Below RBC
Volatile Organics				
1,1,1,2-Tetrachloroethane	0 / 10		No	Not Detected
1,1,1-Trichloroethane	0 / 10		No	Not Detected
1,1,2,2-Tetrachloroethane	0 / 10		No	Not Detected
1,1,2-Trichloroethane	0 / 10		No	Not Detected
1,1-Dichloroethane	0 / 10		No	Not Detected
1,1-Dichloroethene	0 / 10		No	Not Detected
1,2,3-Trichloropropane	0 / 10		No	Not Detected
1,2-Dichloroethane	0 / 10		No	Not Detected
1,2-Dichloropropane	0 / 10		No	Not Detected
2-Butanone (MEK)	0 / 10		No	Not Detected
2-Chloroethyl vinyl ether	0 / 10		No	Not Detected
2-Hexanone	0 / 10		No	Not Detected
4-Methyl-2-pentanone (MIBK)	0 / 10		No	Not Detected
Acetone	7 / 10	0.046	No	Below RBC
Acrolein	0 / 10		No	Not Detected
Acrylonitrile	0 / 10		No	Not Detected
Benzene	0 / 10		No	Not Detected
Bromodichloromethane	0 / 10		No	Not Detected
Bromoform	0 / 10		No	Not Detected
Bromomethane	0 / 10		No	Not Detected
Carbon disulfide	0 / 10		No	Not Detected
Carbon tetrachloride	0 / 10		No	Not Detected
Chlorobenzene	5 / 10	0.026	No	Below RBC
Chloroethane	0 / 10		No	Not Detected
Chloroform	0 / 10		No	Not Detected
Chloromethane	0 / 10		No	Not Detected
cis-1,3-Dichloropropene	0 / 10		No	Not Detected
Dibromochloromethane	0 / 10		No	Not Detected
Dibromomethane	0 / 10		No	Not Detected
Dichlorodifluoromethane	0 / 10		No	Not Detected
Ethanol	0 / 10		No	Not Detected
Ethyl methacrylate	0 / 10		No	Not Detected
Ethylbenzene	0 / 10		No	Not Detected
Iodomethane	0 / 10		No	Not Detected
Methylene chloride	0 / 10		No	Not Detected
Styrene	0 / 10		No	Not Detected

TABLE 2-7

CHEMICALS OF POTENTIAL CONCERN SCREENING
OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Frequency of Detection			Maximum Detected (mg/kg)	COPC?	Reason For Exclusion[a]
Tetrachloroethene	0	/	10		No	Not Detected
Toluene	1	/	10	0.0013	No	Below RBC
trans-1,2-Dichloroethene	0	/	10		No	Not Detected
trans-1,3-Dichloropropene	0	/	10		No	Not Detected
trans-1,4-Dichloro-2-butene	0	/	10		No	Not Detected
Trichloroethene	0	/	10		No	Not Detected
Trichlorofluoromethane	0	/	10		No	Not Detected
Vinyl acetate	0	/	10		No	Not Detected
Vinyl chloride	0	/	10		No	Not Detected
Xylenes (total)	0	/	10		No	Not Detected

Note:

a. Below RBC - see RBC comparison on Table 2-13
Below RDA - see RDA comparison on Table 2-19
Below Background - see background comparison on Table 2-25

TABLE 2-8

COMPARISON TO WATER QUALITY CRITERIA
OFF-BASE WEST SOLDIER CREEK SURFACE WATER

Chemical	Maximum Surface Water Concentration (mg/L)	Federal Water Quality Standard[a] (mg/L)	Selected as COPC?
Metals			
Aluminum	4.50E-01	NA	Yes
Antimony	1.80E-03	1.40E-02	No
Barium	4.30E-01	NA	Yes
Cadmium	3.00E-04	NA	Yes
Calcium	5.32E+01	NA	Yes
Chromium	1.20E-02	NA	Yes
Cobalt	1.60E-04	NA	Yes
Copper	5.50E-03	NA	Yes
Iron	5.90E-01	NA	Yes
Lead[b]	1.90E-03	1.50E-02	No
Magnesium	2.34E+01	NA	Yes
Manganese	4.70E-02	NA	Yes
Mercury	6.40E-05	1.40E-04	No
Molybdenum	3.50E-03	NA	Yes
Nickel	6.20E-03	6.10E-01	No
Potassium	1.30E+00	NA	Yes
Selenium	1.10E-03	NA	Yes
Silver	8.10E-05	NA	Yes
Sodium	2.42E+01	NA	Yes
Thallium	3.80E-05	1.70E-03	No
Vanadium	1.40E-02	NA	Yes
Zinc	3.90E-02	NA	Yes
Semivolatile Organics			
bis(2-Ethylhexyl)phthalate	3.60E-03	1.80E-03	Yes
Di-n-butyl phthalate	2.00E-03	2.70E+00	No

Note:

a. Water Quality Standard for human health - consumption of water and organisms (7/97).

b. Safe Drinking Water Act Action Level for lead used as screening level.

TABLE 2-9

COMPARISON TO WATER QUALITY CRITERIA
ON-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Maximum Surface Water Concentration (mg/L)	Federal Water Quality Standard[a] (mg/L)	Selected as COPC?
Metals			
Aluminum	8.80E-01	NA	Yes
Antimony	6.90E-04	1.40E-02	No
Barium	5.20E-01	NA	Yes
Beryllium	6.80E-05	NA	Yes
Cadmium	1.00E-02	NA	Yes
Calcium	5.53E+01	NA	Yes
Chromium	2.50E-02	NA	Yes
Cobalt	4.50E-04	NA	Yes
Copper	1.40E-01	NA	Yes
Iron	1.00E+00	NA	Yes
Lead[b]	9.10E-03	1.50E-02	No
Magnesium	2.65E+01	NA	Yes
Manganese	5.30E-02	NA	Yes
Molybdenum	3.60E-03	NA	Yes
Nickel	1.50E-02	6.10E-01	No
Potassium	1.90E+00	NA	Yes
Selenium	2.20E-03	NA	Yes
Sodium	3.63E+01	NA	Yes
Thallium	4.20E-05	1.70E-03	No
Vanadium	1.60E-02	NA	Yes
Zinc	5.60E-02	NA	Yes
PCBs/Pesticides			
Dieldrin	2.90E-05	1.40E-07	Yes
Heptachlor	2.40E-05	2.10E-07	Yes
Semivolatile Organics			
bis(2-Ethylhexyl)phthalate	1.40E-01	1.80E-03	Yes
Volatile Organics			
Acetone	3.80E-03	NA	Yes
Bromoform	1.40E-03	4.30E-03	No
Methylene chloride	2.20E-03	4.70E-03	No
Tetrachloroethene	1.50E-03	8.00E-04	Yes

Note:

a. Water Quality Standard for human health - consumption of water and organisms (7/97).

b. Safe Drinking Water Act Action Level for lead used as screening level.

TABLE 2-10

COMPARISON TO WATER QUALITY CRITERIA
OFF-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Maximum Surface Water Concentration (mg/L)	Federal Water Quality Standard[a] (mg/L)	Selected as COPC?
Metals			
Aluminum	5.00E-01	NA	Yes
Antimony	1.90E-03	1.40E-02	No
Barium	4.60E-01	NA	Yes
Cadmium	2.70E-03	NA	Yes
Calcium	4.93E+01	NA	Yes
Chromium	1.20E-02	NA	Yes
Cobalt	2.70E-04	NA	Yes
Copper	2.00E-02	NA	Yes
Iron	1.20E+00	NA	Yes
Lead[b]	3.80E-03	1.50E-02	No
Magnesium	2.30E+01	NA	Yes
Manganese	1.20E-01	NA	Yes
Mercury	4.60E-05	1.40E-04	No
Molybdenum	3.10E-03	NA	Yes
Nickel	6.70E-03	6.10E-01	No
Potassium	1.80E+00	NA	Yes
Selenium	3.90E-03	NA	Yes
Sodium	1.98E+01	NA	Yes
Thallium	4.30E-05	1.70E-03	No
Vanadium	1.30E-02	NA	Yes
Zinc	3.20E-02	NA	Yes
Volatile Organics			
Acetone	3.20E-03	NA	Yes

Note:

a. Water Quality Standard for human health - consumption of water and organisms (7/97).

b. Safe Drinking Water Act Action Level for lead used as screening level.

TABLE 2-11

COMPARISON TO RISK-BASED CONCENTRATIONS OFF-BASE WEST SOLDIER CREEK SEDIMENT

Chemical	Maximum Sediment Concentration (mg/kg)	RBC[a] (mg/day)	Retained as COPC?
Metals			
Aluminum	4.22E+03	7.80E+03	No
Arsenic	1.22E+01	4.30E-01	Yes
Barium	7.90E+02	5.50E+02	Yes
Beryllium	5.30E-01	1.60E+01	No
Cadmium	1.21E+01	7.80E+00	Yes
Calcium	5.71E+04	NA	Yes
Chromium	9.06E+01	2.30E+01	Yes
Cobalt	9.60E+00	4.70E+02	No
Copper	1.94E+01	3.10E+02	No
Iron	1.50E+04	2.30E+03	Yes
Lead[b]	3.62E+01	4.00E+02	No
Magnesium	1.79E+04	NA	Yes
Manganese	6.37E+02	1.60E+02	Yes
Molybdenum	4.20E+00	3.90E+01	No
Nickel	7.87E+01	1.60E+02	No
Potassium	8.91E+02	NA	Yes
Selenium	3.10E+00	3.90E+01	No
Silver	8.60E+00	3.90E+01	No
Thallium	4.31E+01	5.50E-01	Yes
Vanadium	2.67E+01	5.50E+01	No
Zinc	1.03E+02	2.30E+03	No
PCBs/Pesticides			
Aroclor 1254	4.60E+00	1.60E-01	Yes
Semivolatile Organics			
Acenaphthene	9.30E-02	4.70E+02	No
Anthracene	2.90E-01	2.30E+03	No
Benzidine	8.90E-02	2.80E-03	Yes
Benzo(a)anthracene	5.70E-01	8.70E-01	No
Benzo(a)pyrene	5.80E-01	8.70E-02	Yes
Benzo(b)fluoranthene	4.00E-01	8.70E-01	No
Benzo(g,h,i)perylene[c]	6.20E-01	2.30E+02	No
Benzo(k)fluoranthene	5.80E-01	8.70E+00	No
bis(2-Ethylhexyl)phthalate	3.80E-01	4.60E+01	No
Butyl benzyl phthalate	6.80E-02	1.60E+03	No
Chrysene	6.80E-01	8.70E+01	No
Dibenz(a,h)anthracene	1.80E-01	8.70E-02	Yes
Fluoranthene	1.60E+00	3.10E+02	No
Fluorene	1.10E-01	3.10E+02	No
Indeno(1,2,3-cd)pyrene	4.90E-01	8.70E-01	No
Phenanthrene[c]	9.70E-01	2.30E+02	No
Pyrene	1.20E+00	2.30E+02	No
Volatile Organics			
Acetone	5.10E-03	7.80E+02	No

Note:

a. USEPA Region III Residenital Risk-Based Concentration for Soil Ingestion.
RBC adjusted to hazard quotient of 0.1 for noncarcinogens and based on a risk level of $1x10^{-6}$ for carcinogens.

b. Residential screening level for lead in soil is 400 mg/kg.

c. RBC for pyrene used as surrogate.

TABLE 2-12

COMPARISON TO RISK-BASED CONCENTRATIONS ON-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Maximum Sediment Concentration (mg/kg)	RBC[a] (mg/day)	Retained as COPC?
Metals			
Aluminum	1.19E+04	7.80E+03	Yes
Antimony	7.40E+00	3.10E+00	Yes
Arsenic	9.70E+00	4.30E-01	Yes
Barium	1.56E+03	5.50E+02	Yes
Beryllium	9.70E-01	1.60E+01	No
Cadmium	2.91E+02	7.80E+00	Yes
Calcium	1.84E+05	NA	Yes
Chromium	1.83E+03	2.30E+01	Yes
Cobalt	3.11E+01	4.70E+02	No
Copper	1.39E+03	3.10E+02	Yes
Iron	1.85E+04	2.30E+03	Yes
Lead[b]	1.28E+03	4.00E+02	Yes
Magnesium	1.05E+04	NA	Yes
Manganese	5.37E+03	1.60E+02	Yes
Mercury[c]	2.90E+00	7.80E-01	Yes
Molybdenum	6.28E+01	3.90E+01	Yes
Nickel	3.59E+03	1.60E+02	Yes
Potassium	1.72E+03	NA	Yes
Selenium	3.20E+00	3.90E+01	No
Silver	6.45E+01	3.90E+01	Yes
Sodium	2.44E+02	NA	Yes
Thallium	6.18E+01	5.50E-01	Yes
Vanadium	9.22E+01	5.50E+01	Yes
Zinc	4.89E+02	2.30E+03	No
PCBs/Pesticides			
4,4'-DDD	5.70E-03	2.70E+00	No
4,4'-DDE	1.00E-01	1.90E+00	No
Aldrin	1.10E-01	3.80E-02	Yes
Aroclor 1254	1.30E+01	1.60E-01	Yes
Endosulfan II	5.90E-01	4.70E+01	No
gamma-Chlordane	2.50E-02	1.80E+00	No
Semivolatile Organics			
1,2-Dichlorobenzene	1.10E+01	7.00E+02	No
1,3-Dichlorobenzene	1.10E+00	2.30E+02	No
1,4-Dichlorobenzene	6.30E+00	2.70E+01	No
2,4-Dimethylphenol	6.20E-02	1.60E+02	No
2-Chloronaphthalene	7.10E-01	6.30E+02	No
2-Methylnaphthalene	1.60E+00	1.60E+02	No
2-Methylphenol	8.30E-02	3.90E+02	No
Acenaphthene	2.40E+00	4.70E+02	No
Acenaphthylene[d]	9.00E-02	2.30E+02	No
Anthracene	1.20E+01	2.30E+03	No
Benzidine	9.40E-02	2.80E-03	Yes
Benzo(a)anthracene	4.60E+01	8.70E-01	Yes

TABLE 2-12

COMPARISON TO RISK-BASED CONCENTRATIONS ON-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Maximum Sediment Concentration (mg/kg)	RBC[a] (mg/day)	Retained as COPC?
Benzo(a)pyrene	6.30E+01	8.70E-02	Yes
Benzo(b)fluoranthene	5.50E+01	8.70E-01	Yes
Benzo(g,h,i)perylene[d]	6.00E+01	2.30E+02	No
Benzo(k)fluoranthene	5.90E+01	8.70E+00	Yes
bis(2-Ethylhexyl)phthalate	1.60E+01	4.60E+01	No
Chrysene	6.60E+01	8.70E+01	No
Dibenz(a,h)anthracene	1.50E+01	8.70E-02	Yes
Dibenzofuran	1.40E+00	3.10E+01	No
Di-n-butyl phthalate	5.30E-02	7.80E+02	No
Di-n-octyl phthalate	5.10E-01	1.60E+02	No
Fluoranthene	1.60E+02	3.10E+02	No
Fluorene	4.20E+00	3.10E+02	No
Indeno(1,2,3-cd)pyrene	4.90E+01	8.70E-01	Yes
Naphthalene	9.40E+00	1.60E+02	No
Phenanthrene[d]	7.00E+01	2.30E+02	No
Phenol	4.60E-02	4.70E+03	No
Pyrene	1.20E+02	2.30E+02	No
Volatile Organics			
2-Butanone (MEK)	6.20E-02	4.70E+03	No
Acetone	2.10E-01	7.80E+02	No
Acrylonitrile	1.40E-02	1.20E+00	No
Carbon disulfide	1.00E-02	7.80E+02	No
Chlorobenzene	2.00E+01	1.60E+02	No
Dichlorodifluoromethane	4.30E-03	1.60E+03	No
Ethylbenzene	6.00E-02	7.80E+02	No
Methylene chloride	6.90E-03	8.50E+01	No
Tetrachloroethene	2.20E-03	1.20E+01	No
Toluene	2.50E-03	1.60E+03	No
Trichlorofluoromethane	3.50E-03	2.30E+03	No
Xylenes (total)	9.40E-03	1.60E+04	No

Note:

a. USEPA Region III Residenital Risk-Based Concentration for Soil Ingestion. RBC adjusted to hazard quotient of 0.1 for noncarcinogens and based on a risk level of $1x10^{-6}$ for carcinogens.

b. Residential screening level for lead in soil is 400 mg/kg.

c. RBC for methylmercury.

d. RBC for pyrene used as surrogate.

TABLE 2-13

COMPARISON TO RISK-BASED CONCENTRATIONS OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Maximum Sediment Concentration (mg/kg)	RBC[a] (mg/day)	Retained as COPC?
Metals			
Aluminum	7.95E+03	7.80E+03	Yes
Antimony	2.90E+00	3.10E+00	No
Arsenic	2.80E+00	4.30E-01	Yes
Barium	4.55E+03	5.50E+02	Yes
Beryllium	5.90E-01	1.60E+01	No
Cadmium	5.20E+01	7.80E+00	Yes
Calcium	4.03E+04	NA	Yes
Chromium	2.69E+02	2.30E+01	Yes
Cobalt	5.70E+00	4.70E+02	No
Copper	2.86E+01	3.10E+02	No
Iron	1.14E+04	2.30E+03	Yes
Lead[b]	2.17E+01	4.00E+02	No
Magnesium	1.49E+04	NA	Yes
Manganese	9.26E+02	1.60E+02	Yes
Mercury[c]	2.80E-02	7.80E-01	No
Molybdenum	3.30E+00	3.90E+01	No
Nickel	7.47E+01	1.60E+02	No
Potassium	1.08E+03	NA	Yes
Selenium	1.20E+00	3.90E+01	No
Silver	8.00E+00	3.90E+01	No
Vanadium	2.08E+01	5.50E+01	No
Zinc	3.33E+01	2.30E+03	No
PCBs/Pesticides			
Aroclor 1254	2.50E-02	1.60E-01	No
Semivolatile Organics			
Benzo(a)anthracene	6.60E-02	8.70E-01	No
Benzo(a)pyrene	1.50E-01	8.70E-02	Yes
Benzo(b)fluoranthene	8.80E-02	8.70E-01	No
Benzo(g,h,i)perylene[d]	7.40E-02	2.30E+02	No
Benzo(k)fluoranthene	9.50E-02	8.70E+00	No
bis(2-Ethylhexyl)phthalate	3.60E-01	4.60E+01	No
Chrysene	1.20E-01	8.70E+01	No
Fluoranthene	3.50E-01	3.10E+02	No
Indeno(1,2,3-cd)pyrene	6.60E-02	8.70E-01	No
Naphthalene	4.40E-02	1.60E+02	No
Phenanthrene[d]	1.50E-01	2.30E+02	No
Pyrene	1.90E-01	2.30E+02	No
Volatile Organics			
Acetone	4.60E-02	7.80E+02	No
Chlorobenzene	2.60E-02	1.60E+02	No
Toluene	1.30E-03	1.60E+03	No

Note:

a. USEPA Region III Residenital Risk-Based Concentration for Soil Ingestion.

TABLE 2-13

COMPARISON TO RISK-BASED CONCENTRATIONS
OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Maximum Sediment Concentration (mg/kg)	RBC[a] (mg/day)	Retained as COPC?

RBC adjusted to hazard quotient of 0.1 for noncarcinogens and based on a risk level of $1x10^{-6}$ for carcinogens.

b. Residential screening level for lead in soil is 400 mg/kg.

c. RBC for methylmercury.

d. RBC for pyrene used as surrogate.

TABLE 2-14

EVALUATION OF ESSENTIAL NUTRIENTS
OFF-BASE WEST SOLDIER CREEK SURFACE WATER

Chemical	Surface Water Concentration[a] (mg/L)	Daily Ingestion[b] (mg/day)	RDA[c] (mg/day)	Selected as COPC?
Calcium	53.2	26.6	1200	No
Magnesium	23.4	11.7	400	No
Potassium	1.3	0.65	2000	No
Sodium	24.2	12.1	500	No

Note:

a. Maximum detected concentration.

b. Assumes an individual who ingests 0.5 L/day of surface water.

c. Recommended Daily Allowance established by the National Research Council (1989).

TABLE 2-15

EVALUATION OF ESSENTIAL NUTRIENTS
ON-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Surface Water Concentration[a] (mg/L)	Daily Ingestion[b] (mg/day)	RDA[c] (mg/day)	Selected as COPC?
Calcium	55.3	27.65	1200	No
Magnesium	26.5	13.25	400	No
Potassium	1.9	0.95	2000	No
Sodium	36.3	18.15	500	No

Note:

a. Maximum detected concentration.

b. Assumes an individual who ingests 0.5 L/day of surface water.

c. Recommended Daily Allowance established by the National Research Council (1989).

TABLE 2-16

EVALUATION OF ESSENTIAL NUTRIENTS
OFF-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Surface Water Concentration[a] (mg/L)	Daily Ingestion[b] (mg/day)	RDA[c] (mg/day)	Selected as COPC?
Calcium	49.3	24.65	1200	No
Magnesium	23	11.5	400	No
Potassium	1.8	0.9	2000	No
Sodium	19.8	9.9	500	No

Note:

a. Maximum detected concentration.

b. Assumes an individual who ingests 0.5 L/day of surface water.

c. Recommended Daily Allowance established by the National Research Council (1989).

TABLE 2-17

EVALUATION OF ESSENTIAL NUTRIENTS
OFF-BASE WEST SOLDIER CREEK SEDIMENT

Chemical	Sediment Concentration[a] (mg/kg)	Daily Ingestion[b] (mg/day)	RDA[c] (mg/day)	Selected as COPC?
Calcium	57100	5.71	1200	No
Magnesium	17900	1.79	400	No
Potassium	891	0.0891	2000	No

Note:

a. Maximum detected concentration.

b. Assumes an individual who ingests 100 mg of sediment per day.

c. Recommended Daily Allowance established by the National Research Council (1989).

TABLE 2-18

EVALUATION OF ESSENTIAL NUTRIENTS ON-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Sediment Concentration[a] (mg/kg)	Daily Ingestion[b] (mg/day)	RDA[c] (mg/day)	Selected as COPC?
Calcium	184000	18.4	1200	No
Magnesium	10500	1.05	400	No
Potassium	1720	0.172	2000	No
Sodium	244	0.0244	500	No

Note:

a. Maximum detected concentration.

b. Assumes an individual who ingests 100 mg of sediment per day.

c. Recommended Daily Allowance established by the National Research Council (1989).

TABLE 2-19

EVALUATION OF ESSENTIAL NUTRIENTS
OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Sediment Concentration[a] (mg/kg)	Daily Ingestion[b] (mg/day)	RDA[c] (mg/day)	Selected as COPC?
Calcium	40300	4.03	1200	No
Magnesium	14900	1.49	400	No
Potassium	1080	0.108	2000	No

Note:

a. Maximum detected concentration.

b. Assumes an individual who ingests 100 mg of sediment per day.

c. Recommended Daily Allowance established by the National Research Council (1989).

TABLE 2-20

EVALUATION OF BACKGROUND LEVELS
OFF-BASE WEST SOLDIER CREEK SURFACE WATER

Chemical	Background Screening Concentration[a] (mg/L)	Maximum Detected Concentration (mg/L)	Chemical Selected as COPC?
Aluminum	2.19	0.45	No
Barium	0.774	0.43	No
Copper	0.025	0.0055	No
Iron	1.77	0.59	No
Manganese	0.414	0.047	No
Zinc	0.062	0.039	No

Note:

a. Samples from off-base Crutcho Creek were used to identify background concentrations.
Screeing concentration is 2 x average background concentration.

TABLE 2-21

EVALUATION OF BACKGROUND LEVELS ON-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Background Screening Concentration[a] (mg/L)	Maximum Detected Concentration (mg/L)	Chemical Selected as COPC?
Aluminum	2.19	0.88	No
Barium	0.774	0.52	No
Copper	0.025	0.14	Yes
Iron	1.77	1	No
Manganese	0.414	0.053	No
Zinc	0.062	0.056	No

Note:

a. Samples from off-base Crutcho Creek were used to identify background concentrations. Screeing concentration is 2 x average background concentration.

TABLE 2-22

EVALUATION OF BACKGROUND LEVELS
OFF-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Background Screening Concentration[a] (mg/L)	Maximum Detected Concentration (mg/L)	Chemical Selected as COPC?
Aluminum	2.19	0.5	No
Barium	0.774	0.46	No
Copper	0.025	0.02	No
Iron	1.77	1.2	No
Manganese	0.414	0.12	No
Zinc	0.062	0.032	No

Note:

a. Samples from off-base Crutcho Creek were used to identify background concentrations.
Screeing concentration is 2 x average background concentration.

TABLE 2-23

EVALUATION OF BACKGROUND LEVELS
OFF-BASE WEST SOLDIER CREEK SEDIMENT

Chemical	Background Screening Concentration[a] (mg/kg)	Maximum Detected Concentration (mg/kg)	Chemical Selected as COPC?
Arsenic	9	12.2	Yes
Barium	2,251	790	No
Chromium	27	91	Yes
Iron	26,012	15,000	No
Manganese	2,514	637.0	No

Note:

a. Samples from off-base Crutcho Creek were used to identify background concentrations. Screeing concentration is 2 x average background concentration.

TABLE 2-24

EVALUATION OF BACKGROUND LEVELS ON-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Background Screening Concentration[a] (mg/kg)	Maximum Detected Concentration (mg/kg)	Chemical Selected as COPC?
Aluminum	18,193	11,900	No
Arsenic	9.3	9.7	Yes
Barium	2,251	1,560	No
Chromium	26.8	1,830	Yes
Copper	19.0	1,390	Yes
Iron	26,012	18,500	No
Lead	28.8	1,280	Yes
Manganese	2,514	5,370	Yes
Nickel	31.0	3,590	Yes
Zinc	62.0	489	Yes

Note:

a. Samples from off-base Crutcho Creek were used to identify background concentrations. Screeing concentration is 2 x average background concentration.

TABLE 2-25

EVALUATION OF BACKGROUND LEVELS
OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Background Screening Concentration[a] (mg/kg)	Maximum Detected Concentration (mg/kg)	Chemical Selected as COPC?
Aluminum	18,193	7,950	No
Arsenic	9.3	2.8	No
Barium	2,251	4,550	Yes
Cadmium	1.2	52	Yes
Chromium	26.8	269	Yes
Iron	26,012	11,400	No
Manganese	2,514	926	No

Note:

a. Samples from off-base Crutcho Creek were used to identify background concentrations. Screeing concentration is 2 x average background concentration.

TABLE 2-26

CHEMICALS OF POTENTIAL CONCERN
OFF-BASE WEST SOLDIER CREEK SURFACE WATER

Chemical	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Frequency of Detection
Metals			
Cadmium	0.0003	0.0003	2/4
Chromium	0.012	0.0038	4/4
Cobalt	0.00016	0.00016	2/4
Molybdenum	0.0035	0.0017	4/4
Selenium	0.0011	0.00097	2/4
Silver	0.000081	0.000081	1/4
Vanadium	0.014	0.011	4/4
Semivolatile Organics			
bis(2-Ethylhexyl)phthalate	0.0036	0.0036	1/4

TABLE 2-27

CHEMICALS OF POTENTIAL CONCERN
ON-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Frequency of Detection
Metals			
Beryllium	0.000068	0.000068	1/18
Cadmium	0.01	0.000077	12/18
Chromium	0.025	0.0047	18/18
Cobalt	0.00045	0.000092	9/18
Copper	0.14	0.0058	18/18
Molybdenum	0.0036	0.00018	14/18
Selenium	0.0022	0.0005	9/18
Vanadium	0.016	0.012	18/18
Pesticides/PCBs			
Dieldrin	0.000029	0.000029	1/18
Heptachlor	0.000024	0.000024	1/18
Semivolatile Organics			
bis(2-Ethylhexyl)phthalate	0.14	0.0018	3/18
Volatile Organics			
Acetone	0.0038	0.0012	9/18
Tetrachloroethene	0.0015	0.0015	1/18

TABLE 2-28

CHEMICALS OF POTENTIAL CONCERN
OFF-BASE EAST SOLDIER CREEK SURFACE WATER

Chemical	Maximum Detected Concentration (mg/L)	Minimum Detected Concentration (mg/L)	Frequency of Detection
Metals			
Cadmium	0.0027	0.00064	4/4
Chromium	0.012	0.0065	4/4
Cobalt	0.00027	0.00019	2/4
Molybdenum	0.0031	0.0011	4/4
Selenium	0.0039	0.0013	2/4
Vanadium	0.013	0.011	4/4
Volatile Organics			
Acetone	0.0032	0.0032	1/4

TABLE 2-29

CHEMICALS OF POTENTIAL CONCERN
OFF-BASE WEST SOLDIER CREEK SEDIMENT

Chemical	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Frequency of Detection
Metals			
Arsenic	12.2	1.2	4/4
Cadmium	12.1	0.74	4/4
Chromium	90.6	25.8	4/4
Thallium	43.1	8.6	3/4
Pesticides/PCBs			
Aroclor 1254	4.6	0.28	4/4
Semivolatile Organics			
Benzidine	0.089	0.089	1/4
Benzo(a)pyrene	0.58	0.042	3/4
Dibenz(a,h)anthracene	0.18	0.18	1/4

TABLE 2-30

CHEMICALS OF POTENTIAL CONCERN SCREENING ON-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Frequency of Detection
Metals			
Antimony[a]	7.4	7.4	1/34
Arsenic	9.7	0.82	31/34
Cadmium	291	0.71	25/34
Chromium	1830	9.8	34/34
Copper	1390	6.5	34/34
Lead	1280	4.9	34/34
Manganese	5370	103	33/34
Mercury	2.9	0.016	22/34
Molybdenum	62.8	1.9	23/35
Nickel	3590	6.4	34/34
Silver	64.5	0.45	22/34
Thallium	61.8	1.7	11/34
Vanadium	92.2	5.2	34/34
Pesticides/PCBs			
Aldrin	0.11	0.11	1/34
Aroclor 1254	13	0.076	10/34
Semivolatile Organics			
Benzidine[a]	0.094	0.094	1/34
Benzo(a)anthracene	46	0.083	29/34
Benzo(a)pyrene	63	0.06	29/34
Benzo(b)fluoranthene	55	0.093	29/34
Benzo(k)fluoranthene	59	0.092	28/34
Dibenz(a,h)anthracene	15	0.074	20/34
Indeno(1,2,3-cd)pyrene	49	0.062	29/34

Note:

a. Antimony and benzidine were only retained as COCs for the future scenario because they were not detected in the shallow sediment.

TABLE 2-31

CHEMICALS OF POTENTIAL CONCERN
OFF-BASE EAST SOLDIER CREEK SEDIMENT

Chemical	Maximum Detected Concentration (mg/kg)	Minimum Detected Concentration (mg/kg)	Frequency of Detection
Metals			
Barium	4550	249	10/10
Cadmium	52	1.4	7/10
Chromium	269	7.9	10/10
Semivolatile Organics			
Benzo(a)pyrene	0.15	0.082	2/10

FIGURES

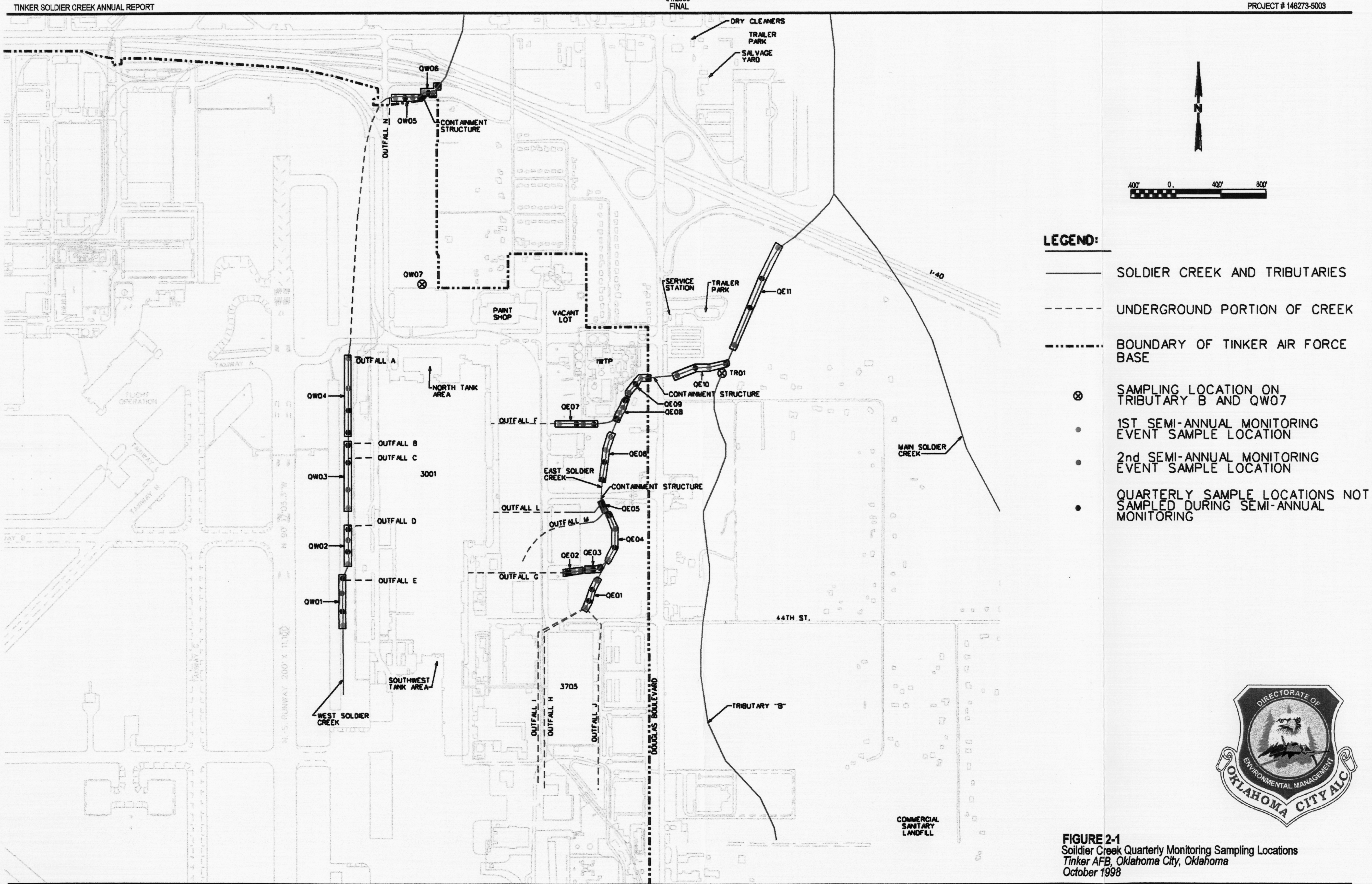

FIGURE 2-1
Soildier Creek Quarterly Monitoring Sampling Locations
Tinker AFB, Oklahoma City, Oklahoma
October 1998

3.0 EXPOSURE ASSESMENT

Exposure assessment is the estimation of the magnitude of potential chemical exposure to various receptors. The magnitude of exposure is determined by measuring or estimating the amount of a chemical available at the exchange boundaries (i.e., the lungs, gastrointestinal tract, and skin) and estimating the frequency and duration of the exposure. Exposure can occur when contaminants migrate from the contaminant source to the exposure point, or when a receptor comes into direct contact with waste or contaminated media. The steps involved in exposure assessment include:

- Identification of potential receptor populations
- Evaluation of potential exposure pathways
- Estimation of exposure point concentrations
- Estimation of daily intake factors

This RA incorporated conservative exposure assumptions when estimating the magnitude of potential exposure to ensure that potential risks posed by the site were not underestimated. Exposure scenarios that were considered unlikely were excluded, since they do not reflect realistic exposure conditions. Exposure can be defined for both the reasonable maximum exposure (RME) and the average exposure. The RME represents the most exposed individual in a population, while the average exposure represents the most likely exposure for the potentially exposed population. Both RME and average exposure scenarios were evaluated.

3.1 IDENTIFICATION OF POTENTIAL RECEPTOR POPULATIONS

The potential receptor populations identified in the previous RAs (WCFS 1996, 1997b, 1997c) were evaluated in this current RA. Populations evaluated include those individuals most likely to come into contact with contaminated surface water and sediment in the three stream segments based on current and potential future use.

Because Tinker AFB is an active military facility with restricted access, local off-Base populations cannot readily access the facility and contact the on-Base portion of East Soldier Creek. Exposure to the on-Base portion of East Soldier Creek is also likely to be minimal for the majority of the site workers and visitors. Therefore, it was assumed that the population with the greatest potential for contact with surface water and sediment from the on-Base portion of East Soldier Creek would be a construction worker involved in repair or installation of underground pipelines around or under the creek. Because land use at Tinker AFB is unlikely to change in the foreseeable future, this scenario was considered a maximum exposure scenario for both current and future site use conditions.

Off-Base portions of East and West Soldier Creeks flow through several residential and non-residential areas. Access to the creek in these areas is essentially unrestricted, and therefore, a number of different receptors could potentially contact stream sediment and surface water. The maximum exposed receptor is most likely a local resident (adult and child) who uses the creek recreationally and swims or wades in the creek. This is particularly true for children, for whom the stream may act as an "attractive nuisance." Evaluation of the residential scenario for the off-Base stream segments would be protective of all local populations under both current and future use conditions.

Potential receptor populations that do not represent realistic exposure scenarios were excluded from consideration in the RA. Although sensitive populations (e.g., pregnant women, the elderly or infirm. etc.) are likely to be located within the greater metropolitan area of Oklahoma City, they were excluded from the quantitative evaluation because these populations are not likely to be exposed to the media of concern (surface water and sediment).

In summary, the receptor populations evaluated quantitatively in the previous RAs and this current RA include:

- On-Base construction worker
- Off-Base child resident
- Off-Base adult resident

3.2 EVALUATION OF POTENTIAL EXPOSURE PATHWAYS

An exposure pathway describes the mechanism by which a receptor may be exposed to a chemical at or originating from the site. A complete exposure pathway includes a source and a mechanism of chemical release, a retention or transport medium, an exposure point, and an exposure route (e.g., ingestion). Exposure can not occur, and a health risk does not exist, unless the exposure pathway is complete. The absence of any one element of the exposure pathway results in an incomplete pathway.

The potential exposure pathways for the three Soldier Creek segments evaluated in the RA are identified in the site conceptual exposure model (Figure 3-1). The conceptual exposure model identifies the four elements of each exposure pathway and is used to identify complete exposure pathways. Potential on-Base sources of chemical release were identified in Section 1.2. The mechanism of release refers to the physicochemical properties of the chemicals that influence their mobility and potential contact with a receptor. The potential receptors were discussed in Section 3.1. The potential exposure pathways identified in the site conceptual exposure model are evaluated in the following sections.

3.2.1 Identification of Potential Sources

Numerous on-Base and off-Base sources of chemical releases have been identified in previous investigations (B&V 1993, NUS 1989). Potential on-base sources of contamination to Soldier Creek were discussed in Section 1.2 and include:

- Outfalls from Building 3001
- Building 3001
- Southwest tank area
- North tank area
- IWTP (inactivated April 1996)

In addition, several potential off-Base sources of releases have been identified (B&V 1993):

- A paint shop

- A trailer park (northeast of Tinker AFB)
- An auto repair shop
- A service station
- A salvage yard

3.2.2 Identification of Potential Exposure Points and Exposure Routes

Exposure points are the locations, on- and off-Base, where potentially exposed populations may contact contaminated media. Exposure points include the surface water and sediment in on-Base and off-Base segments of East Soldier Creek and the off-Base segment of West Soldier Creek.

Exposure routes are the mode of contact (inhalation, ingestion, or dermal contact) with the contaminated media. On-Base construction workers could be exposed to contaminants in surface water and sediment in on-Base portions of East Soldier Creek via incidental ingestion and dermal contact while performing excavation or construction activities.

Off-Base residents may be exposed to contaminants in surface water and sediment in off-Base portions of East and West Soldier Creek through incidental ingestion and dermal contact during recreational activities. The water level in the off-Base portion of West Soldier Creek generally is very shallow and swimming is not possible. Therefore, contact while wading in the off-Base portion of West Soldier Creek was evaluated. Several off-Base portions of East Soldier Creek are deep enough for swimming, and potentially could be used by children for swimming. Therefore, although Soldier Creek does not include any swimming areas per se, a child resident swimming scenario was evaluated for the off-Base portion of East Soldier Creek. A wading scenario was evaluated for adults for the off-Base portion of East Soldier Creek, since adults are not as likely to swim in the creek as children are. Exposure via ingestion and dermal contact with surface water and sediment was evaluated for both children and adults.

Inhalation exposure was assumed to be minor or incomplete for all scenarios and was not evaluated. East and West Soldier Creeks are located in open, unconfined areas where atmospheric dilution would quickly attenuate the concentrations of volatilized compounds released from the creek. Although the USEPA Region IV Guidance (USEPA 1996) suggests that in most cases it is unnecessary to evaluate human exposures to sediment covered by surface water, incidental ingestion and dermal contact with sediment were conservatively evaluated for all receptors.

Potential exposure to contaminants in the surface water and sediment via ingestion of fish or game animals was assumed to be a minor or incomplete exposure pathway and was not evaluated in the RA. East and West Soldier Creeks do not have viable game or fish populations, and the location of Tinker AFB within the metropolitan area of Oklahoma City precludes any hunting activities.

3.3 ESTIMATION OF EXPOSURE POINT CONCENTRATION

The exposure point concentrations are the chemical concentrations at the point of receptor contact. Exposure concentrations may be measured directly (i.e., surface water concentrations) or calculated using fate and transport models. Fate and transport modeling was not necessary for this RA since surface water and sediment data were collected at the potential exposure locations. RME and average exposure point concentrations were calculated for the COPCs and are presented in Tables 3-1 through 3-8.

For the calculation of exposure point concentrations for the COPCs, chemicals were assumed to be present at one-half the detection limit for any sample where no detectable chemical quantities were found in that specific sample, but the chemical was detected in that medium for that group of samples. For cases where a duplicate sample was collected, the chemical concentration detected in the primary sample was assumed representative of the sample concentration. Estimated values flagged with a 'J' qualifier were treated as unqualified detected concentrations. Data qualified with an 'R' (rejected) were not used in the risk assessment. Data qualified with a 'B', indicating blank contamination, were assumed not detected, and one-half the 'B' qualified value was assumed representative of the sample concentration. This is the same methodology followed for calculation of the exposure point concentrations in the previous risk assessments.

The 95 percent upper confidence limit (95% UCL) of the mean based on a lognormal distribution, or the maximum concentration detected, whichever was lower, was selected as the RME exposure point concentration. It is generally reasonable to assume that sampling data are lognormally distributed, therefore the 95% UCL calculation was based on a lognormal distribution (USEPA 1992c). Use of the maximum concentration, if less than the 95% UCL, is recommended by USEPA (USEPA 1992c). The RME exposure point concentration or the mean concentration, whichever was lower, was adopted as the average exposure point concentration.

The 95% UCL for surface water and sediment was calculated as follows:

$$UCL = e^{(m + 0.5S^2 + SH / \sqrt{n-1})}$$

Where:

UCL	=	upper 95 percent confidence level of mean
e	=	constant (Base of natural log, equal to 2.718)
m	=	mean of transformed data
S	=	standard deviation of the transformed data
n	=	number of samples
H	=	H-statistics (from table published in Gilbert 1987)

The exposure point concentrations calculated for surface water were used to calculate risks associated with both current and future use scenarios. As was done in the previous RAs, sediment samples collected from 0 to 0.5 feet were used to calculate exposure point concentrations for current use scenarios. Sediment samples collected from all depths were used to calculate exposure point concentrations for future use scenarios. Only surface sediment samples (0 to 0.5 feet) were collected from off-Base West Soldier Creek. Therefore, the surface sediment samples were used to calculate the exposure point concentrations for both the current and future use scenarios for off-Base West Soldier Creek.

- Table 3-1: current and future off-Base West Soldier Creek surface water exposure point concentrations.

- Table 3-2: current and future on-Base East Soldier Creek surface water exposure point concentrations.

- Table 3-3: current and future off-Base East Soldier Creek surface water exposure point concentrations.
- Table 3-4: current and future off-Base West Soldier Creek sediment exposure point concentrations.
- Table 3-5: current on-Base East Soldier Creek sediment exposure point concentrations.
- Table 3-6: future on-Base East Soldier Creek sediment exposure point concentrations.
- Table 3-7: current off-Base East Soldier Creek sediment exposure point concentrations.
- Table 3-8: future off-Base East Soldier Creek sediment exposure point concentrations.

3.4 CALCULATION OF DAILY INTAKES

The quantification of exposure is based on an estimate of the chronic daily intake (CDI), the amount of the chemical entering the receptor's body per day. CDIs were calculated for individual chemicals and receptors, using the following equations that were used in the previous RAs:

Surface water ingestion for on-Base worker scenario:

$$CDI = (CW \times IR \times ET \times EF \times ED)/(BW \times CF2 \times AT)$$

Surface water dermal exposure for on-Base worker scenario:

$$CDI = (CW \times SA \times PC \times ET \times EF \times ED \times CF1)/(BW \times CF2 \times AT)$$

Sediment ingestion for on-Base worker scenario:

$$CDI = (CS \times CF1 \times IR \times EF \times ED)/(BW \times CF2 \times AT)$$

Sediment dermal exposure for on-Base worker scenario:

$$CDI = (CS \times CF1 \times SA \times AF \times ABS \times EF \times ED)/(BW \times CF2 \times AT)$$

Surface water ingestion for off-Base residential scenario:

$$CDI = CW \times HIF \quad \text{and}$$

$$HIF = [(IRc \times ETc \times EFc \times EDc) / BWc + (IRa \times ETa \times EFa \times EDa) / BWa] / (CF2 \times AT)$$

Surface water dermal exposure for off-Base residential scenario:

$$CDI = CW \times HIF \quad \text{and}$$

$$HIF = \{[(SAc \times PC \times ETc \times EFc \times EDc) / BWc + (SAa \times PC \times ETa \times EFa \times EDa)/BWa]/(CF2 \times AT)\} \times CF1$$

Sediment ingestion for off-Base residential scenario:

$$CDI = CW \times HIF \times CF1 \quad \text{and}$$

$$HIF = [(IRc \times EFc \times EDc) / BWc + (IRa \times EFa \times EDa) / BWa]/ (CF2 \times AT)$$

Sediment dermal exposure for off-Base residential scenario:

$$CDI = CS \times HIF \times CF1 \quad \text{and}$$

$$HIF = \{[(SAc \times EFc \times EDc \times ABS) / BWc + (SAa \times EFa \times EDa \times ABS) / BWa] \times AF\} / (CF2 \times AT)$$

Where:

- *CDI* = Chronic Daily Intake (mg/kg-day)
- *HIF* = Human Intake Factor (L/kg-day for surface water, mg/kg-day for sediment)
- *CW* = Concentration in Surface Water (mg/L)
- *CS* = Concentration in Sediment (mg/kg)
- *IR* = Ingestion Rate (L/hour for surface water, mg/day for sediment)
- *IRc* = Child Resident Ingestion Rate (L/hour for surface water, mg/day for sediment)
- *IRa* = Adult Resident Ingestion Rate (L/hour for surface water, mg/day for sediment)

ET = Worker Exposure Time (hours)
ETc = Child Resident Exposure Time (hours)
ETa = Adult Resident Exposure Time (hours)
SA = Worker Skin Surface Area available for contact (cm^2)
SAc = Child Resident Skin Surface Area available for contact (cm^2)
SAa = Adult Resident Skin Surface Area available for contact (cm^2)
EF = Worker Exposure Frequency (days/year)
EFc = Child Resident Exposure Frequency (days/year)
PC = Dermal Permeability Constant (cm/hr)
EFa = Adult Resident Exposure Frequency (days/year)
ED = Worker Exposure Duration (years)
EDc = Child Resident Exposure Duration (years)
EDa = Adult Resident Exposure Duration (years)
BW = Worker Body Weight (kg)
BWc = Child Body Weight (kg)
BWa = Adult Body Weight (kg)
AF = Adherence Factor (mg/cm^2)
ABS = Absorption Factor (unitless)
AT = Averaging Time (70 years for carcinogenic effects, exposure duration for noncarcinogenic effects)
CF1 = Conversion Factor 1 (0.000001 kg/mg)
CF2 = Conversion Factor 2 (365 days/year)

Attachment A presents the CDI calculations for each medium, route of exposure, and receptor. The majority of the exposure parameter assumptions used in this RA were consistent with those used in the previous RAs (WCFS 1996, 1997b, 1997c). The only exposure parameter value that differed from the value used in the previous RAs was the surface water ingestion rate while wading. This number was changed to reflect the current USEPA Region IV Guidance (USEPA 1996).

The numerical values used for the exposure parameters in the CDI calculations are included in Tables 3-9 through 3-12 and are discussed below. The values were developed in the previous RAs using site-specific information and a number of USEPA references, including the *Exposure Factors Handbook* (USEPA 1989b), *Standard Default Exposure Factors* (USEPA 1991a), *Dermal Exposure Assessment: Principles and Applications* (USEPA

1992a), USEPA Region IV Guidance (USEPA 1996), and RAGS (USEPA 1989a). The exposure assumptions are conservative, and potential exposures and health risks are not likely to be underestimated.

3.4.1 Averaging Time

The averaging time is the time the exposure is averaged over. For carcinogenic chemical exposure, the averaging time is the receptor life span and is assumed to be the same for all receptor populations, and is 70 years (1989a). For exposure to noncarcinogenic chemicals, the averaging time is equal to the exposure duration. For carcinogens, it is assumed that a high dose received over a short period of time is equivalent to a low dose spread over a life-time, while for noncarcinogens it is assumed that chemical effects are only relevant during the period of exposure.

3.4.2 Exposure Duration

Exposure duration is the number of years that exposure occurs. On-Base construction workers were assumed to be full-time employees of Tinker AFB and were assumed to have an RME duration of 25 years (USEPA 1991a). The average exposure duration for an on-Base construction worker was assumed to be 5 years, based on the average time an individual spends at one job (U.S. Department of Labor 1987). The residential RME exposure duration of 30 years (5 years between ages 1-6, and 25 years afterward) is based on the upper 90th percentile value for time spent in a single residence. The average exposure duration for an adult resident was assumed to be 9 years based on the mean time spent at a single residence (EPA 1989b). For child residents, the entire 5-year age span (ages 1-6) was conservatively assumed for average exposure.

3.4.3 Exposure Frequency

Exposure frequency is the number of days per year spent in direct contact with the creek. For RME and average exposure, on-Base construction workers were assumed to spend 5 days per year and 1 day per year, respectively, working in the vicinity of the creek. The adult residential RME exposure frequency was assumed to be 4 days per month during the summer months. The average exposure frequency for the adult resident was assumed to be one half of the RME exposure frequency (2 days/year). Children (ages 1-6) were assumed to spend two days per week during the 17 summer weeks at the creeks for an RME exposure frequency of 34 days per year. One half of the RME exposure frequency (17 days/year) was assumed for average residential child exposure.

3.4.4 Exposure Time

Exposure time refers to the number of hours per day that a receptor is in contact with a potentially contaminated medium. The RME exposure time for on-Base construction workers is assumed to be a workday, or 8 hours per day. For average exposure, one half of the RME exposure time (4 hours/day) is assumed as the fraction of the working day the construction worker would be in direct contact with surface water or sediment in the creek. For adult residents, 2 hours per day was assumed as the RME time and 1 hours per day was assumed for the average exposure. For children, exposure times of 6 and 3 hours per day were assumed for RME and average exposure, respectively.

3.4.5 Sediment Ingestion Rate

The sediment ingestion rate is the amount of sediment that is ingested daily. Upper-bound soil ingestion rates provided by USEPA (1991a) were used to evaluate RME exposure. The RME ingestion rates were 50 mg/day for workers, 100 mg/day for adult residents, and 200 mg/day for children. Typically the RME soil ingestion rate for a construction worker is 480 mg/day, however, because the sediment is covered with surface water, the more appropriate ingestion rate of 50 mg/day was used. For average exposure, ingestion rates of 10 mg/day were assumed for both workers and adult residents, based on information presented in the *Exposure Factors Handbook* (USEPA 1989b). An average ingestion rate of 100 mg/day was assumed for children, based on one-half the RME rate.

3.4.6 Body Weight

Body weights were obtained from the *Exposure Factors Handbook* (USEPA 1989b). An adult body weight of 70 kg was used for the construction worker. Age-weighted average body weights were calculated as 57.1 kg and 15.1 kg, respectively, for the adult and child resident.

3.4.7 Skin Surface Area

Exposed skin surface area is necessary to evaluate uptake of chemicals that are absorbed through the skin. An RME skin surface area of 9,800 cm^2 was estimated for an on-Base construction worker, based on the surface areas of the head, hands, arms, and lower legs of an adult (*Exposure Factors Handbook*; USEPA 1989b). For average exposure, an exposed area of 2,000 cm^2 was assumed for the construction worker based on the surface area of hands and forearms.

Whole body immersion (6,500 cm^2) was assumed for children swimming in the creek for both the RME and average exposure scenarios, as well as for the RME child wading scenario. The average exposed surface area for a child wading in the creek was assumed to be 1,800 cm^2 based on the surface area of the hands, forearms, and feet. For adult residents, an RME surface area of 8,620 cm^2 was assumed based on exposure of the head, hands, forearms, and lower legs. For average exposure, an exposed surface area of 2,800 cm^2 was assumed based on exposure of the hands, forearms, and feet.

3.4.8 Dermal Sediment Adherence

Sediment adherence to the skin is used, in conjunction with exposed skin surface area, to estimate the total amount of sediment adhering to exposed skin surfaces. The USEPA recommends 1.0 mg/cm^2 and 0.2 mg/cm^2 for upper-bound (RME) and average exposure, respectively (USEPA 1992a).

3.4.9 Dermal Absorption Factor

The dermal absorption factor provides an estimate of potential chemical absorption through the skin. As presented in USEPA Region IV guidance (USEPA 1996), dermal absorption was assumed to be 1.0 percent for organic chemicals and 0.1 percent for inorganic chemicals.

3.4.10 Surface Water Ingestion Rate

An RME surface water ingestion rate of 0.05 L/hour was assumed for children swimming in East Soldier Creek (USEPA 1989a). For average exposure while swimming, an ingestion rate of 0.025 L/hour was assumed based on one-half the RME value.

Surface water ingestion while wading was assumed to be the same as swimming (0.05 L/hour RME and 0.025 L/hour average) for the child (USEPA 1996). The RME surface water ingestion rate for the adult worker and resident was assumed to be 0.01 L/hour (USEPA 1996). The average surface water ingestion rate for the adult was assumed to be one-half of the RME value, or 0.005 L/hour.

3.4.11 Permeability Constant

Permeability constants are chemical-specific values used to determine the dermal uptake of chemicals from aqueous media, and are presented in units of cm/hour. Permeability constants used in this RA were obtained from *Dermal Exposure Assessment: Principles and Applications* (USEPA 1992a).

TABLES

TABLE 3-1

EXPOSURE POINT CONCENTRATIONS
OFF-BASE WEST SOLDIER CREEK SURFACE WATER
(CURRENT AND FUTURE SCENARIO)

Chemical	Maximum Detected Concentration (mg/L)	Mean[a] (mg/L)	UCL[a,b] (mg/L)	RME Exposure Point Concentration[c] (mg/L)	Average Exposure Point Concentration[d] (mg/L)
Metals					
Cadmium	3.00E-04	3.23E-04	3.97E-04	3.00E-04	3.00E-04
Chromium	1.20E-02	6.88E-03	3.52E-02	1.20E-02	6.88E-03
Cobalt	1.60E-04	2.20E-04	4.34E-04	1.60E-04	1.60E-04
Molybdenum	3.50E-03	2.78E-03	5.30E-03	3.50E-03	2.78E-03
Selenium	1.10E-03	9.05E-04	1.19E-03	1.10E-03	9.05E-04
Silver	8.10E-05	3.04E-04	3.06E-02	8.10E-05	8.10E-05
Vanadium	1.40E-02	1.23E-02	1.46E-02	1.40E-02	1.23E-02
Semivolatile Organics					
bis(2-Ethylhexyl)phthalate	3.60E-03	4.59E-03	5.83E-03	3.60E-03	3.60E-03

Notes:

a. One half the detection limit is used for all nondetects when calculating values.

b. The upper 95 percent confidence limit values (UCL) of the arithmetic mean concentration assuming lognormal distribution.

c. The concentration associated with the 95 percent UCL or the maximum concentration detected, whichever was lower, was used as the RME exposure point concentration.

d. The RME exposure point concentration or the mean concentration, whichever was lower, was adopted as the average exposure point concentration.

TABLE 3-2

EXPOSURE POINT CONCENTRATIONS ON-BASE EAST SOLDIER CREEK SURFACE WATER (CURRENT AND FUTURE SCENARIO)

Chemical	Maximum Detected Concentration (mg/L)	Mean[a] (mg/L)	UCL[a,b] (mg/L)	RME Exposure Point Concentration[c] (mg/L)	Average Exposure Point Concentration[d] (mg/L)
Metals					
Beryllium	6.80E-05	4.76E-04	6.28E-04	6.80E-05	6.80E-05
Cadmium	1.00E-02	1.23E-03	3.70E-03	3.70E-03	1.23E-03
Chromium	2.50E-02	9.88E-03	1.29E-02	1.29E-02	9.88E-03
Cobalt	4.50E-04	2.08E-04	2.61E-04	2.61E-04	2.08E-04
Copper	1.40E-01	5.46E-02	1.02E-01	1.02E-01	5.46E-02
Molybdenum	3.60E-03	1.13E-03	1.94E-03	1.94E-03	1.13E-03
Selenium	2.20E-03	8.78E-04	1.20E-03	1.20E-03	8.78E-04
Vanadium	1.60E-02	1.33E-02	1.37E-02	1.37E-02	1.33E-02
Pesticides/PCBs					
Dieldrin	2.90E-05	4.85E-05	5.13E-05	2.90E-05	2.90E-05
Heptachlor	2.40E-05	2.48E-05	2.50E-05	2.40E-05	2.40E-05
Semivolatile Organics					
bis(2-Ethylhexyl)phthalate	1.40E-01	1.22E-02	1.30E-02	1.30E-02	1.22E-02
Volatile Organics					
Acetone	3.80E-03	3.73E-03	4.75E-03	3.80E-03	3.73E-03
Tetrachloroethene	1.50E-03	1.50E-03	1.50E-03	1.50E-03	1.50E-03

Notes:

a. One half the detection limit is used for all nondetects when calculating values.

b. The upper 95 percent confidence limit values (UCL) of the arithmetic mean concentration assuming lognormal distribution.

c. The concentration associated with the 95 percent UCL or the maximum concentration detected, whichever was lower, was used as the RME exposure point concentration.

d. The RME exposure point concentration or the mean concentration, whichever was lower, was adopted as the average exposure point concentration.

TABLE 3-3

EXPOSURE POINT CONCENTRATIONS
OFF-BASE EAST SOLDIER CREEK SURFACE WATER
(CURRENT AND FUTURE SCENARIO)

Chemical	Maximum Detected Concentration (mg/L)	Mean[a] (mg/L)	UCL[a,b] (mg/L)	RME Exposure Point Concentration[c] (mg/L)	Average Exposure Point Concentration[d] (mg/L)
Metals					
Cadmium	2.70E-03	1.69E-03	1.94E-02	2.70E-03	1.69E-03
Chromium	1.20E-02	8.68E-03	1.43E-02	1.20E-02	8.68E-03
Cobalt	2.70E-04	2.25E-04	2.82E-04	2.70E-04	2.25E-04
Molybdenum	3.10E-03	2.05E-03	1.07E-02	3.10E-03	2.05E-03
Selenium	3.90E-03	1.61E-03	9.30E-02	3.90E-03	1.61E-03
Vanadium	1.30E-02	1.20E-02	1.32E-02	1.30E-02	1.20E-02
Volatile Organics					
Acetone	3.20E-03	3.53E-03	1.26E-01	3.20E-03	3.20E-03

Notes:

a. One half the detection limit is used for all nondetects when calculating values.

b. The upper 95 percent confidence limit values (UCL) of the arithmetic mean concentration assuming lognormal distribution.

c. The concentration associated with the 95 percent UCL or the maximum concentration detected, whichever was lower, was used as the RME exposure point concentration.

d. The RME exposure point concentration or the mean concentration, whichever was lower, was adopted as the average exposure point concentration.

TABLE 3-4

EXPOSURE POINT CONCENTRATIONS
OFF-BASE WEST SOLDIER CREEK SEDIMENT
(CURRENT AND FUTURE SCENARIO)

Chemical	Maximum Detected Concentration (mg/kg)	Mean[a] (mg/kg)	UCL[a,b] (mg/kg)	RME Exposure Point Concentration[c] (mg/kg)	Average Exposure Point Concentration[d] (mg/kg)
Metals					
Arsenic	1.22E+01	4.50E+00	1.43E+03	1.22E+01	4.50E+00
Cadmium	1.21E+01	4.39E+00	4.79E+03	1.21E+01	4.39E+00
Chromium	9.06E+01	6.89E+01	4.76E+02	9.06E+01	6.89E+01
Thallium	4.31E+01	1.91E+01	4.76E+09	4.31E+01	1.91E+01
Pesticides/PCBs					
Aroclor 1254	4.60E+00	1.74E+00	1.82E+03	4.60E+00	1.74E+00
Semivolatile Organics					
Benzidine	8.90E-02	1.50E+00	6.68E+05	8.90E-02	8.90E-02
Benzo(a)pyrene	5.80E-01	2.26E-01	1.85E+02	5.80E-01	2.26E-01
Dibenz(a,h)anthracene	1.80E-01	1.93E-01	2.05E-01	1.80E-01	1.80E-01

Notes:

a. One half the detection limit is used for all nondetects when calculating values.

b. The upper 95 percent confidence limit values (UCL) of the arithmetic mean concentration assuming lognormal distribution.

c. The concentration associated with the 95 percent UCL or the maximum concentration detected, whichever was lower, was used as the RME exposure point concentration.

d. The RME exposure point concentration or the mean concentration, whichever was lower. was adopted as the average exposure point concentration.

TABLE 3-5

EXPOSURE POINT CONCENTRATIONS ON-BASE EAST SOLDIER CREEK SEDIMENT (CURRENT SCENARIO)

Chemical	Maximum Detected Concentration (mg/kg)	Mean[a,b] (mg/kg)	UCL[a,b,c] (mg/kg)	RME Exposure Point Concentration[d] (mg/kg)	Average Exposure Point Concentration[e] (mg/kg)
Metals					
Arsenic	9.70E+00	3.41E+00	6.29E+00	6.29E+00	3.41E+00
Cadmium	2.91E+02	3.12E+01	2.79E+02	2.79E+02	3.12E+01
Chromium	7.32E+02	2.48E+02	9.68E+02	7.32E+02	2.48E+02
Copper	1.39E+03	2.57E+02	1.61E+03	1.39E+03	2.57E+02
Lead	1.28E+03	1.55E+02	4.14E+02	4.14E+02	1.55E+02
Manganese	5.37E+03	6.67E+02	1.11E+03	1.11E+03	6.67E+02
Mercury	1.20E+00	3.16E-01	1.85E+00	1.20E+00	3.16E-01
Molybdenum	6.28E+01	1.20E+01	4.88E+01	4.88E+01	1.20E+01
Nickel	3.59E+03	2.82E+02	8.71E+02	8.71E+02	2.82E+02
Silver	1.63E+01	3.06E+00	6.58E+00	6.58E+00	3.06E+00
Thallium	6.18E+01	3.18E+01	1.95E+03	6.18E+01	3.18E+01
Vanadium	9.22E+01	2.77E+01	4.16E+01	4.16E+01	2.77E+01
Pesticides/PCBs					
Aldrin	1.10E-01	2.68E-02	1.71E-01	1.10E-01	2.68E-02
Aroclor 1254	1.30E+01	1.77E+00	4.15E+01	1.30E+01	1.77E+00
Semivolatile Organics					
Benzo(a)anthracene	8.00E+00	1.82E+00	8.03E+00	8.00E+00	1.82E+00
Benzo(a)pyrene	9.30E+00	1.99E+00	8.65E+00	8.65E+00	1.99E+00
Benzo(b)fluoranthene	1.30E+01	2.14E+00	9.41E+00	9.41E+00	2.14E+00
Benzo(k)fluoranthene	8.30E+00	1.73E+00	6.93E+00	6.93E+00	1.73E+00
Dibenz(a,h)anthracene	2.70E+00	6.58E-01	1.23E+00	1.23E+00	6.58E-01
Indeno(1,2,3-cd)pyrene	7.90E+00	1.64E+00	7.10E+00	7.10E+00	1.64E+00

Notes:

a. Surface (0-0.5 feet) sediment data are used in the calculations.

b. One half the detection limit is used for all nondetects when calculating values.

c. The upper 95 percent confidence limit values (UCL) of the arithmetic mean concentration assuming lognormal distribution.

d. The concentration associated with the 95 percent UCL or the maximum concentration detected, whichever was lower, was used as the RME exposure point concentration.

e. The RME exposure point concentration or the mean concentration, whichever was lower, was adopted as the average exposure point concentration.

TABLE 3-6

EXPOSURE POINT CONCENTRATIONS
ON-BASE EAST SOLDIER CREEK SEDIMENT
(FUTURE SCENARIO)

Chemical	Maximum Detected Concentration (mg/kg)	Mean[a,b] (mg/kg)	UCL[a,b,c] (mg/kg)	RME Exposure Point Concentration[d] (mg/kg)	Average Exposure Point Concentration[e] (mg/kg)
Metals					
Antimony	7.40E+00	4.01E+00	4.61E+00	4.61E+00	4.01E+00
Arsenic	9.70E+00	2.98E+00	3.97E+00	3.97E+00	2.98E+00
Cadmium	2.91E+02	3.56E+01	1.49E+02	1.49E+02	3.56E+01
Chromium	1.83E+03	3.02E+02	6.19E+02	6.19E+02	3.02E+02
Copper	1.39E+03	1.74E+02	4.21E+02	4.21E+02	1.74E+02
Lead	1.28E+03	1.34E+02	2.31E+02	2.31E+02	1.34E+02
Manganese	5.37E+03	5.71E+02	7.12E+02	7.12E+02	5.71E+02
Mercury	2.90E+00	3.49E-01	8.27E-01	8.27E-01	3.49E-01
Molybdenum	6.28E+01	9.08E+00	1.64E+01	1.64E+01	9.08E+00
Nickel	3.59E+03	1.88E+02	2.67E+02	2.67E+02	1.88E+02
Silver	6.45E+01	6.13E+00	9.89E+00	9.89E+00	6.13E+00
Thallium	6.18E+01	4.40E+01	1.11E+03	6.18E+01	4.40E+01
Vanadium	9.22E+01	2.40E+01	2.98E+01	2.98E+01	2.40E+01
Pesticides/PCBs					
Aldrin	1.10E-01	8.92E-02	2.66E-01	1.10E-01	8.92E-02
Aroclor 1254	1.30E+01	2.59E+00	1.73E+01	1.30E+01	2.59E+00
Semivolatile Organics					
Benzidine	9.40E-02	9.57E+00	1.78E+01	9.40E-02	9.40E-02
Benzo(a)anthracene	4.60E+01	4.10E+00	9.39E+00	9.39E+00	4.10E+00
Benzo(a)pyrene	6.30E+01	4.82E+00	1.12E+01	1.12E+01	4.82E+00
Benzo(b)fluoranthene	5.50E+01	4.66E+00	1.00E+01	1.00E+01	4.66E+00
Benzo(k)fluoranthene	5.90E+01	4.28E+00	8.38E+00	8.38E+00	4.28E+00
Dibenz(a,h)anthracene	1.50E+01	1.34E+00	1.77E+00	1.77E+00	1.34E+00
Indeno(1,2,3-cd)pyrene	4.90E+01	3.81E+00	7.74E+00	7.74E+00	3.81E+00

Notes:

a. Sediment data from all depths are used in the calculations.

b. One half the detection limit is used for all nondetects when calculating values.

c. The upper 95 percent confidence limit values (UCL) of the arithmetic mean concentration assuming lognormal distribution.

d. The concentration associated with the 95 percent UCL or the maximum concentration detected, whichever was lower, was used as the RME exposure point concentration.

e. The RME exposure point concentration or the mean concentration, whichever was lower, was adopted as the average exposure point concentration.

TABLE 3-7

EXPOSURE POINT CONCENTRATIONS
OFF-BASE EAST SOLDIER CREEK SEDIMENT
(CURRENT SCENARIO)

Chemical	Maximum Detected Concentration (mg/kg)	Mean[a,b] (mg/kg)	UCL[a,b,c] (mg/kg)	RME Exposure Point Concentration[d] (mg/kg)	Average Exposure Point Concentration[e] (mg/kg)
Metals					
Barium	4.55E+03	1.48E+03	2.03E+06	4.55E+03	1.48E+03
Cadmium	5.20E+01	2.02E+01	1.75E+09	5.20E+01	2.02E+01
Chromium	2.69E+02	1.34E+02	4.10E+05	2.69E+02	1.34E+02
Semivolatile Organics					
Benzo(a)pyrene	8.20E-02	1.78E-01	6.30E-01	8.20E-02	8.20E-02

Notes:

a. Surface (0-0.5 feet) sediment data are used in the calculations.

b. One half the detection limit is used for all nondetects when calculating values.

c. The upper 95 percent confidence limit values (UCL) of the arithmetic mean concentration assuming lognormal distribution.

d. The concentration associated with the 95 percent UCL or the maximum concentration detected, whichever was lower, was used as the RME exposure point concentration.

e. The RME exposure point concentration or the mean concentration, whichever was lower, was adopted as the average exposure point concentration.

TABLE 3-8

EXPOSURE POINT CONCENTRATIONS
OFF-BASE EAST SOLDIER CREEK SEDIMENT
(FUTURE SCENARIO)

Chemical	Maximum Detected Concentration (mg/kg)	Mean[a,b] (mg/kg)	UCL[a,b,c] (mg/kg)	RME Exposure Point Concentration[d] (mg/kg)	Average Exposure Point Concentration[e] (mg/kg)
Metals					
Barium	4.55E+03	8.01E+02	1.44E+03	1.44E+03	8.01E+02
Cadmium	5.20E+01	1.12E+01	5.21E+02	5.20E+01	1.12E+01
Chromium	2.69E+02	6.95E+01	2.79E+02	2.69E+02	6.95E+01
Semivolatile Organics					
Benzo(a)pyrene	1.50E-01	1.94E-01	2.41E-01	1.50E-01	1.50E-01

Notes:

a. Sediment data from all depths are used in the calculations.

b. One half the detection limit is used for all nondetects when calculating values.

c. The upper 95 percent confidence limit values (UCL) of the arithmetic mean concentration assuming lognormal distribution.

d. The concentration associated with the 95 percent UCL or the maximum concentration detected, whichever was lower, was used as the RME exposure point concentration.

e. The RME exposure point concentration or the mean concentration, whichever was lower, was adopted as the average exposure point concentration.

TABLE 3-9

EXPOSURE PARAMETERS
INGESTION OF SURFACE WATER

Parameter	ADULT RESIDENT		CHILD RESIDENT		CONSTRUCTION WORKER	
	RME [a]	AVERAGE	RME [a]	AVERAGE	RME [a]	AVERAGE
(IR) Ingestion Rate - wading (L/hour)	0.01 [c]	0.005 [l]	0.05 [c]	0.025 [l]	0.01 [c]	0.005 [l]
(IR) Ingestion Rate - Swimming (L/hour)[b]	na	na	0.05 [d]	0.025 [l]	na	na
(ET) Exposure Time (hours/day)	2	1 [l]	6	3 [l]	8	4 [l]
(ED) Exposure Duration (years)	25 [e]	9 [f]	5 [e]	5 [o]	25 [g]	5 [g]
(EF) Exposure Frequency (days/year)	4 [h]	2 [l]	34 [i]	17 [l]	5 [j]	1 [j]
(BW) Body Weight (kg)	57.1 [k]	57.1 [k]	15.1 [k]	15.1 [k]	70	70
(AT1) Averaging Time - Noncarcinogenic Effects (years)[m]	25	9	5	5	25	5
(AT2) Averaging Time - Cancer Effects (years)[n]	70	70	70	70	70	70

Note:

a. Reasonable Maximum Exposure (RME) is defined by EPA as the reasonable upperbound exposure among potentially exposed populations.
b. Swimming is only evaluated for the child scenario in off-base portions of East Soldier Creek.
c. Surface water ingestion rate while wading as identified in Region IV Supplemental Risk Guidance (USEPA, 1986).
d. Surface water ingestion rate while swimming as identified in RAGS (USEPA, 1989a).
e. Residents are assumed to have a RME duration of 30 years (5 years between age 1-6, 25 years as adult), based on the upper 90th percentile value for time spent in a single residence (Exposure Factors Handbook, USEPA,1989b).
f. Average duration at a single residence is 9 years, as identified in Exposure Factors Handbook (USEPA, 1989b).
g. Construction workers are assumed to have an RME duration of 25 years as given in OSWER Directive 9285.6-03 (USEPA, 1991a). For average exposure, the exposure duration of 5 years is based on the average time spent at a job (U.S. Department of Labor, 1987).
h. Assumes 1 day/month exposure during the 4 months of summer.
i. Assumes 2 day/week exposure for the 17 weeks of summer.
j. Exposure frequency for construction workers assumes minor construction activities in the creek.
k. Age-weighted average.
l. Assumed value based on one-half the RME value.
m. Averaging time for noncarcinogenic effects is based on the exposure duration.
n. Averaging time for carcinogenic effects is based on lifetime of 70 years.
o. Average exposure duration for a child assumes entire 5-year age span (age 1-6).
na. Not applicable.

TABLE 3-10

EXPOSURE PARAMETERS
DERMAL CONTACT WITH SURFACE WATER

Exposure Parameter	ADULT RESIDENT		CHILD RESIDENT		CONSTRUCTION WORKER	
	RME [a]	AVERAGE	RME [a]	AVERAGE	RME [a]	AVERAGE
(SA) Exposed Surface Area - wading (cm^2)	8,620 [c,m]	2,800 [e,m]	6,500 [d,m]	1,800 [e,m]	9,800 [c]	2,000 [f]
(SA) Exposed Surface Area - swimming (cm^2)[b]	na	na	6,500 [d,m]	6,500 [d,m]	na	na
(PC) Dermal Permeability Constant (cm/hour)	Chemical-Specific					
(ET) Exposure Time (hours/day)	2	1 [o]	6	3 [o]	8	4 [o]
(ED) Exposure Duration (years)	25 [g]	9 [h]	5 [g]	5 [r]	25 [i]	5 [i]
(EF) Exposure Frequency (days/year)	4 [j]	2 [o]	34 [k]	17 [o]	5 [l]	1 [l]
(BW) Body Weight (kg)	57.1 [m]	57.1 [m]	15.1 [m]	15.1 [m]	70	70
(AT1) Averaging Time - Noncarcinogenic Effects (years)[p]	25	9	5	5	25	5
(AT2) Averaging Time - Cancer Effects (years)[q]	70	70	70	70	70	70

Note:

a. Reasonable Maximum Exposure (RME) is defined by EPA as the reasonable upperbound exposure among potentially exposed populations.
b. Swimming is only evaluated for the child scenario in off-base portions of East Soldier Creek.
c. The surface area of head, hands, arms, and lower legs is assumed for RME.
d. Exposed surface area is based on whole body exposure.
e. Average exposure assumes surface area of hands, forearms, and feet.
f. Average exposed surface area for construction workers based on hands and forearms.
g. Residents are assumed to have a RME duration of 30 years (5 years between age 1-6, 25 years as adult), based on the upper 90th percentile value for time spent in a single residence (Exposure Factors Handbook, USEPA,1989b).
h. Average duration at a single residence is 9 years, as identified in Exposure Factors Handbook (USEPA, 1989b).
i. Construction workers are assumed to have an RME duration of 25 years as given in OSWER Directive 9285.6-03 (USEPA, 1991a). For average exposure, the exposure duration of 5 years is based on the average time spent at a job (U.S. Department of Labor, 1987).
j. Assumes 1 day/month exposure during the 4 months of summer.
k. Assumes 2 day/week exposure for the 17 weeks of summer.
l. Exposure frequency for construction workers assumes minor construction activities in the creek.
m. Age-weighted average.
o. Assumed value based on one-half the RME value.
p. Averaging time for noncarcinogenic effects is based on the exposure duration.
q. Averaging time for carcinogenic effects is based on lifetime of 70 years.
r. Average exposure duration for a child assumes entire 5-year age span (age 1-6).
na. Not applicable.

TABLE 3-11

EXPOSURE PARAMETERS
INGESTION OF SEDIMENTS

Exposure Parameter	ADULT RESIDENT		CHILD RESIDENT		CONSTRUCTION WORKER	
	RME [a]	AVERAGE	RME [a]	AVERAGE	RME [a]	AVERAGE
(IR) Ingestion Rate (mg/day)	100 [b]	10 [c]	200 [b]	100 [k]	50 [b]	10 [c]
(ED) Exposure Duration (years)	25 [d]	9 [e]	5 [d]	5 [n]	25 [f]	5 [f]
(EF) Exposure Frequency (days/year)	4 [g]	2 [k]	34 [h]	17 [k]	5 [i]	1 [i]
(BW) Body Weight (kg)	57.1 [j]	57.1 [j]	15.1 [j]	15.1 [j]	70	70
(AT1) Averaging Time - Noncarcinogenic Effects (years)[l]	25	9	5	5	25	5
(AT2) Averaging Time - Cancer Effects (years)[m]	70	70	70	70	70	70

Note:

a. Reasonable Maximum Exposure (RME) is defined by EPA as the reasonable upperbound exposure among potentially exposed populations.
b. For RME, standard default sediment ingestion rates of 100 mg/day for adult resident, 200mg/day for children and 50 mg/day for workers were assumed (USEPA, 1991b).
c. Average ingestion rate as identified in Exposure Factors Handbook (USEPA, 1989b).
d. Residents are assumed to have a RME duration of 30 years (5 years between age 1-6, 25 years as adult), based on the upper 90th percentile value for time spent in a single residence (Exposure Factors Handbook, USEPA,1989b).
e. Average duration at a single residence is 9 years, as identified in Exposure Factors Handbook (USEPA, 1989b).
f. Construction workers are assumed to have an RME duration of 25 years as given in OSWER Directive 9285.6-03 (USEPA, 1991a). For average exposure, the exposure duration of 5 years is based on the average time spent at a job (U.S. Department of Labor, 1987).
g. Assumes 1 day/month exposure during the 4 months of summer.
h. Assumes 2 day/week for the 17 weeks of summer.
i. Exposure frequency for construction workers assumes minor construction activities in the creek.
j. Age-weighted average.
k. Assumed value based on one-half the RME value.
l. Averaging time for noncarcinogenic effects is based on the exposure duration.
m. Averaging time for carcinogenic effects is based on assumed lifetime of 70 years.
n. Average exposure duration for a child assumes entire 5-year age span (age 1-6).

TABLE 3-12

EXPOSURE PARAMETERS
DERMAL CONTACT WITH SEDIMENTS

Exposure Parameter	ADULT RESIDENT		CHILD RESIDENT		CONSTRUCTION WORKER	
	RME [a]	AVERAGE	RME [a]	AVERAGE	RME [a]	AVERAGE
(SA) Exposed Surface Area - wading (cm^2)	8,620 [b,n]	2,800 [b,n]	6,500 [c,n]	1,800 [c,n]	9,800 [b]	2,000 [e]
(SA) Exposed Surface Area - swimming (cm^2)	na	na	6,500 [d,n]	6,500 [d,n]	na	na
(AF) Dermal Sediment Adherence (mg/cm^2)	1.00 [f]	0.20 [f]	1.00 [f]	0.20 [f]	1.00 [f]	0.20 [f]
(ABS) Absorption Factor (unitless)	Chemical Specific [g]					
(ED) Exposure Duration (years)	25 [h]	9 [i]	5 [h]	5 [r]	25 [j]	5 [j]
(EF) Exposure Frequency (days/year)	4 [k]	2 [o]	34 [l]	17 [o]	5 [m]	1 [m]
(BW) Body Weight (kg)	57.1 [n]	57.1 [n]	15.1 [n]	15.1 [n]	70	70
(AT1) Averaging Time - Noncarcinogenic Effects (years)[p]	25	9	5	5	25	5
(AT2) Averaging Time - Cancer Effects (years)[q]	70	70	70	70	70	70

Note:

a. Reasonable Maximum Exposure (RME) is defined by EPA as the reasonable upperbound exposure among potentially exposed populations.
b. The surface area of head, hands, arms, and lower legs is assumed for RME. The surface area of hands, forearms and feet is assumed for average exposure.
c. Exposed surface area is based on whole body for RME. For average exposure, surface area of hands, forearms, and feet are used.
d. Exposed surface area is based on whole body for both RME and average exposure.
e. Average exposed surface for construction worker based on hands and forearms.
f. Dermal adherence based on Dermal Exposure Assessment: Principles and Applications (USEPA, 1992a)
g. Based on the EPA Region IV Guidance (USEPA 1992b) 1.0% dermal absorption is assumed for organics and 0.1% for inorganics.
h. Residents are assumed to have a RME duration of 30 years (5 years between age 1-6, 25 years as adult), based on the upper 90th percentile value for time spent in a single residence (Exposure Factors Handbook, USEPA,1989b).
i. Average duration at a single residence is 9 years, as identified in Exposure Factors Handbook (USEPA, 1989b).
j. Construction workers are assumed to have an RME duration of 25 years as given in OSWER Directive 9285.6-03 (USEPA, 1991a). For average exposure, the exposure duration of 5 years is based on the average time spent at a job (U.S. Department of Labor, 1987).
k. Assumes 1 day/month exposure during the 4 months of summer.
l. Assumes 2 day/week exposure for the 17 weeks of summer.
m. Exposure frequency for construction workers assumes minor construction activities in the creek.
n. Age-weighted average.
o. Assumed value based on one-half the RME value.
p. Averaging time for noncarcinogenic effects is based on the exposure duration.
q. Averaging time for carcinogenic effects is based on assumed lifetime of 70 years.
r. Average exposure duration for a child assumes entire 5 year age span (age 1-6).
na. Not applicable.

FIGURES

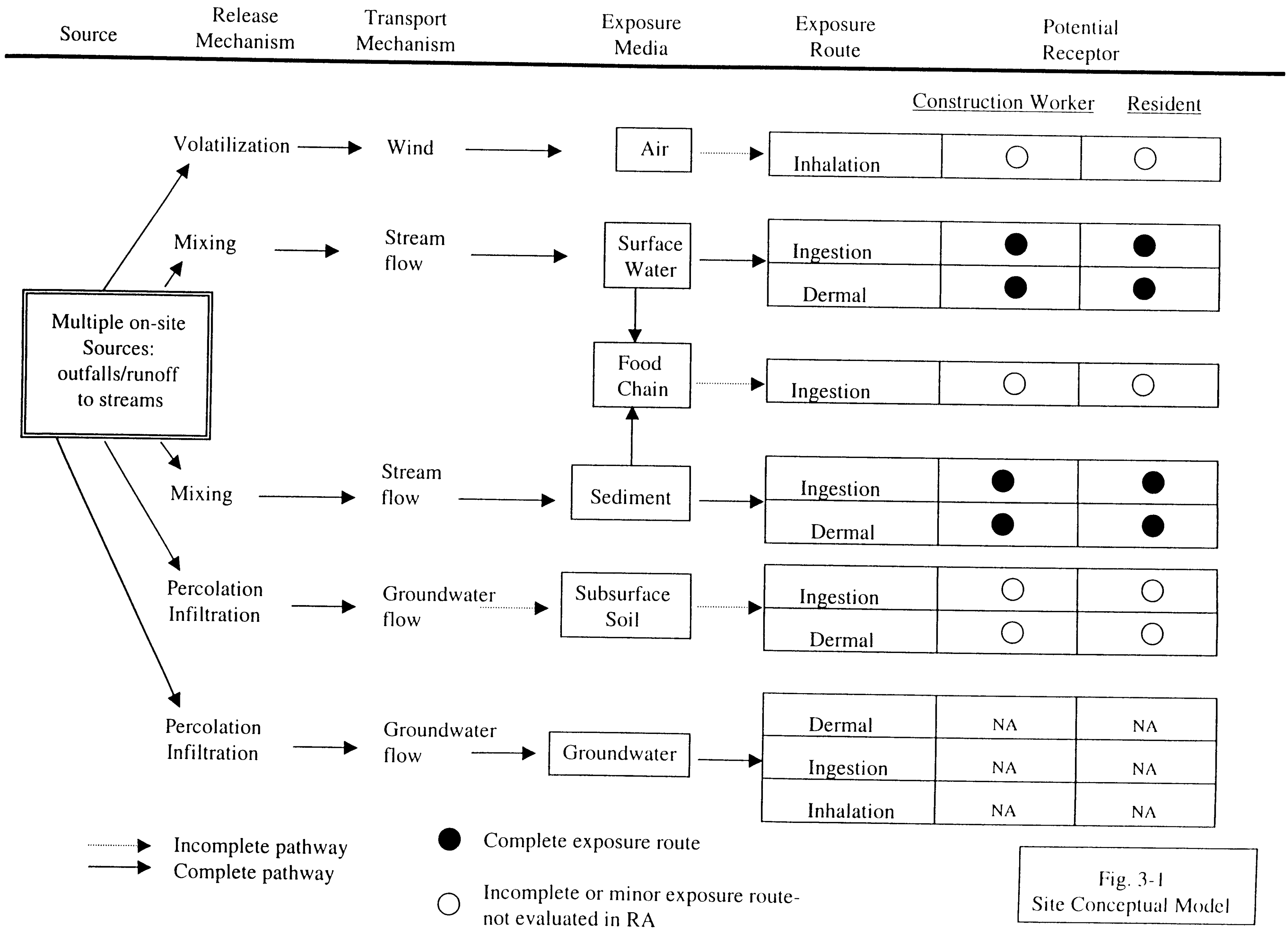

Fig. 3-1
Site Conceptual Model

4.0 TOXICITY ASSESSMENT

The toxicity assessment provides the critical toxicity values (CTVs) for the COPCs. The CTVs are values developed by the USEPA that are used to evaluate potential cancer risks and noncarcinogenic health hazards associated with chemical exposure.

Health effects are divided into two broad groups: noncarcinogenic and carcinogenic. This division is based on the different mechanisms of action associated with each category. Chemicals causing noncarcinogenic health effects were evaluated independently from those having carcinogenic effects. Some chemicals may produce both noncarcinogenic and carcinogenic effects, and were evaluated in both groups.

4.1 TOXICITY ASSESSMENT OF NONCARCINOGENIC EFFECTS

Noncarcinogenic health effects include a variety of toxic effects on body systems, ranging from renal toxicity (toxicity to the kidneys) to central nervous system disorders. The toxicity of a chemical is assessed through a review of toxic effects noted in short-term (acute) animal studies, long-term (chronic) animal studies, and epidemiological investigations.

Substances that produce noncarcinogenic effects are generally thought to have a threshold below which there are no observable adverse health effects. This threshold dose, also known as the no-observed-adverse-effect level (NOAEL), is the highest level (determined in epidemiological studies or animal studies) at which there are no statistically or biologically significant effects of concern, often called the "critical toxic effect." For some substances, only a lowest-observed-adverse-effect level (LOAEL) has been determined. This is the lowest dose of a substance that produces either a statistically or biologically significant indication of the critical toxic effect.

The noncarcinogenic CTV is known as the reference dose (RfD). RfDs are calculated by dividing the NOAEL (or LOAEL if a NOAEL is not available) by uncertainty factors and modifying factors, which generally range from 10 to 1,000. Uncertainties include variations in the sensitivity of individuals within a population and the extrapolation of data from experimental animals to humans. The RfD is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg-day). As long as the chronic daily intake (CDI) of a compound is less than the reference dose, it is believed that there is no noncarcinogenic health effect due to the exposure.

USEPA (1989a) defines the chronic RfD as an estimate of a daily exposure to the human population that is likely to be without appreciable risk of deleterious effects during a lifetime. Chronic RfDs are developed to be protective for long-term exposure to a compound (7 years to a lifetime). Chronic oral RfDs for the COPCs are shown in Table 4-1.

Dermal RfDs were derived from oral RfDs by adjusting the oral value to account for the percent of gastrointestinal (GI) absorption. In this manor, the oral RfD is converted from an administered dose to an absorbed dose so that it is consistent with the absorbed intake calculated for dermal exposure. The oral RfD was multiplied by the GI absorption factor to derive the dermal RfD included in Table 4-1. The GI absorption factors are also included in Table 4-1. Oral RfDs were not adjusted for GI absorption for the dermal exposure scenarios in the three previous RAs.

4.2 TOXICITY ASSESSMENT OF CARCINOGENIC EFFECTS

The carcinogenic CTV is termed the slope factor (SF). Slope factors are developed based on a dose-response curve for carcinogenicity of the specific chemicals. Slope factors are developed from human and animal studies and are designed to be health protective (i.e., to overestimate the actual risks). Slope factors are used to estimate an upper-bound probability of an individual developing cancer as a result of exposure to a potential carcinogen. In addition to deriving a quantitative estimate of cancer potency, USEPA also assigns weight-of-evidence classifications to potential carcinogens. Potential carcinogens are grouped according to the likelihood that the chemical is a human carcinogen based on the quality and quantity of data available on the carcinogenic potency of the chemical. Table 4-2 presents the USEPA weight-of-evidence classification system.

In estimating the risk posed by potential carcinogens, it is the common practice of the USEPA and other regulatory agencies to assume that any exposure level is associated with a finite probability, however minute, of producing a carcinogenic response. In other words, there is no threshold level below which exposure to the chemical would not result in a carcinogenic response.

It is generally assumed by the USEPA in developing SFs that the risk of cancer is linearly related to the dose. A linearized multistage model is commonly used by the USEPA for extrapolation of experimentally derived data to the low dose range. This conservative mathematical model is based on the multistage theory of carcinogenesis wherein the response is assumed to be linear at low doses. From the slope of the extrapolation curve estimated by the model, the USEPA calculates the upper 95th percent confidence limit of the slope. This value, the SF, expressed in units of $(mg/kg\text{-}day)^{-1}$, is used to convert the chronic daily intake of chemical, normalized over a lifetime, directly to a cancer risk. This represents an estimation of an upper-bound incremental lifetime probability that an individual will develop cancer as a result of exposure to a potential carcinogen. This model provides a conservative estimate of cancer risk at low doses, and is likely to overestimate the actual cancer risk. The USEPA acknowledges that actual SFs are likely to be between zero and the estimate provided by the linearized multistage model (USEPA 1989a). The oral SFs and weight-of-evidence classifications for the COPCs are included in Table 4-1.

Dermal SFs were derived from oral SFs by adjusting the oral value to account for the percent of gastrointestinal (GI) absorption. In this manor, the oral SF is converted from an administered dose to an absorbed dose so that it is consistent with the absorbed intake calculated for dermal exposure. The oral SF was divided by the GI absorption factor to derive the dermal SF included in Table 4-1. The GI absorption factors are also included in Table 4-1. Oral SFs were not adjusted for GI absorption for the dermal exposure scenarios in the three previous RAs.

4.3 SOURCES OF CRITICAL TOXICITY VALUES

The RfD and SF values used in the RA were obtained from the following sources:

- USEPA's Integrated Risk Information System on-line database system (USEPA 1998a)

- USEPA's Health Effects Assessment Summary Tables (USEPA 1997)
- USEPA Region III Risk-based Concentration Table (USEPA 1998b)

There are no published toxicity values for two of the COPCs retained in sediment, mercury and lead. The RfD for methylmercury was used as a surrogate RfD for mercury so that it could be quantitatively evaluated in the RA. There is no surrogate toxicity value available for lead, therefore lead was not evaluated quantitatively in the RA, as discussed in Section 5.2.

TABLES

TABLE 4-1

CRITICAL TOXICITY VALUES FOR COCs

Chemical Name	Cancer Class	Oral RfD mg/kg-day	Oral SF $(mg/kg\text{-}day)^{-1}$	GI Absorption Factor	Dermal RfD[f] mg/kg-day	Dermal SF[g] $(mg/kg\text{-}day)^{-1}$
Acetone	D	1.00E-01 [a]		0.83 [e]	8.30E-02	
Aldrin	B2	3.00E-05 [a]	1.70E+01 [a]	0.5 [e]	1.50E-05	3.40E+01
Antimony	D	4.00E-04 [a]		0.02 [e]	8.00E-06	
Aroclor 1254	B2	2.00E-05 [a]	2.00E+00 [a]	0.9 [e]	1.80E-05	2.22E+00
Arsenic	A	3.00E-04 [a]	1.50E+00 [a]	0.41 [e]	1.23E-04	3.66E+00
Barium	D	7.00E-02 [a]		0.07 [e]	4.90E-03	
Benzidine	A	3.00E-03 [a]	2.30E+02 [a]	0.8 [e]	2.40E-03	2.88E+02
Benzo(a)anthracene	B2		7.30E-01 [d]	0.31 [e]		2.35E+00
Benzo(a)pyrene	B2		7.30E+00 [a]	0.31 [e]		2.35E+01
Benzo(b)fluoranthene	B2		7.30E-01 [d]	0.31 [e]		2.35E+00
Benzo(k)fluoranthene	B2		7.30E-02 [d]	0.31 [e]		2.35E-01
Beryllium	B2	2.00E-03 [a]		0.01 [e]	2.00E-05	
Bis(2-ethylhexyl) phthalate	B2	2.00E-02 [a]	1.40E-02 [a]	0.19 [e]	3.80E-03	7.37E-02
Cadmium (Food)	B1	1.00E-03 [a]		0.01 [e]	1.00E-05	
Cadmium (water)	B1	5.00E-04 [a]		0.01 [e]	5.00E-06	
Chromium (III)	D	1.50E+00 [a]		0.005 [e]	7.50E-03	
Chromium (VI)	A	3.00E-03 [a]		0.02 [e]	6.00E-05	
Cobalt	NA	6.00E-02 [c]		0.8 [e]	4.80E-02	
Copper	D	4.00E-02 [b]		0.3 [e]	1.20E-02	
Dibenz(a,h)anthracene	B2		7.30E+00 [d]	0.31 [e]		2.35E+01
Dieldrin	B2	5.00E-05 [a]	1.60E+01 [a]	0.5 [e]	2.50E-05	3.20E+01
Heptachlor	B2	5.00E-04 [a]	4.50E+00 [a]	0.72 [e]	3.60E-04	6.25E+00
Indeno(1,2,3-cd)pyrene	B2		7.30E-01 [d]	0.31 [e]		2.35E+00
Lead	B2	NTF	NTF			
Manganese (nonfood)	D	2.00E-02 [a]		0.04 [e]	8.00E-04	
Manganese (food)	D	1.40E-01 [a]		0.04 [e]	5.60E-03	
Mercury	D	NTF				
Methylmercury	C	1.00E-04 [a]		0.9 [e]	9.00E-05	
Molybdenum	D	5.00E-03 [a]		0.38 [e]	1.90E-03	
Nickel	A	2.00E-02 [a]		0.27 [e]	5.40E-03	
Selenium	D	5.00E-03 [a]		0.44 [e]	2.20E-03	
Silver	D	5.00E-03 [a]		0.18 [e]	9.00E-04	
Tetrachloroethene	C-B2	1.00E-02 [a]	5.20E-02 [c]	1.0 [e]	1.00E-02	5.20E-02
Thallium	D	7.00E-05 [c]		0.15 [e]	1.05E-05	
Vanadium	D	7.00E-03 [b]		0.01 [e]	7.00E-05	

Notes:

a). EPA's Integrated Risk Information System (USEPA Date) on-line database system.
b). EPA's Health Effects Assessment Summary Tables (USEPA 1994)
c). EPA, Region III Risk-Based Concentration table (USEPA 1997).
d). Based on the slope factor of Benzo(a)pyrene x Carcinogenic Equivalency Factor (USEPA 1993).
e). Bast, CB and HT Borges, 1996.
f). Dermal RfD = Oral RfD x GI Absorption Factor
g). Dermal SF = Oral SF / GI Absorption Factor
NTF = No toxicity factors. Surrogate toxicity values for these chemicals are not available; therefore, they were not evaluated in the quantitative risk assessment.

TABLE 4-2

USEPA WEIGHT-OF-EVIDENCE CARCINOGENIC CLASSIFICATION OF CHEMICALS

Group	Description	Description of Evidence
A	Human carcinogen	Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer.
B1 or B2	Probable human carcinogen	B1 indicates that limited human data are available from epidemiologic studies. B2 indicates sufficient evidence in animals and inadequate or no evidence in humans of carcinogenicity.
C	Possible human carcinogen	Limited evidence of carcinogenicity in animals.
D	Not classifiable as to human carcinogenicity	Inadequate evidence of carcinogenicity in animals.
E	No evidence of carcinogenicity in humans	No evidence of carcinogenicity in at least two adequate animal tests or in both epidemiologic and animal studies.

Note: Substances in Groups B and C are considered potential carcinogens.

5.0 RISK CHARACTERIZATION

The purpose of the risk characterization is to estimate the potential health risks associated with exposure to site chemicals. Risk characterization combines the results of the previous elements of the risk assessment to evaluate the potential health risks of exposure to the COPCs.

5.1 PROCEDURE FOR CALCULATION OF POTENTIAL CANCER RISKS AND NONCARCINOGENIC HAZARDS

The potential for noncarcinogenic effects to occur as a result of exposure is evaluated by comparing the exposure level, or chronic daily intake, with the RfD derived for a similar exposure period. A Hazard Quotient (HQ) was calculated for each chemical as follows:

$$HQ = [Chronic\ Daily\ Intake] / [RfD]$$

If exposure is equal to or less than the RfD, the HQ will be equal to or less than 1.0, and it is unlikely that there will be any potential adverse effect due to exposure to that constituent. If exposure exceeds the RfD, the HQ will exceed 1.0, and a hazard may exist. A HQ is developed for each noncarcinogenic COPC, for each exposure pathway. HQs for each chemical are then summed for each exposure pathway to derive the Hazard Index (HI):

$$HI = HQ1 + HQ2 + HQ3 \ldots\ldots\ldots\ldots + HQn$$

The assumption of additivity of sub-threshold HQ values in calculating a HI is only valid if all of the compounds affect the same target organ and there are no antagonistic or synergistic effects between compounds (little is known about these interactions for most chemicals). The first condition is not true for many chemicals (the same target organs for all compounds), while the second assumption represents a major source of uncertainty. The use of a HI in this RA should be considered highly conservative and will likely overestimate the potential for a health hazard.

HIs greater than 1.0 are generally viewed as indicating that exposure to a particular medium may present a potential human health hazard. Exposure pathway HIs are summed across pathways whenever appropriate, since individuals may be simultaneously exposed to chemicals via more than one pathway (e.g., to both sediment and surface water).

Potential cancer risks are calculated for each compound by multiplying the CDI by the respective SF:

$$\textit{Risk Estimate} = \textit{CDI} \times \textit{SF}$$

The estimated cancer risk for each compound may be summed to yield an overall cancer risk for each exposure route. Risks are then summed across pathways, when appropriate, to calculate an overall risk estimate for each exposure scenario. The basis for this approach is the regulatory assumption that cancer risks are additive (USEPA 1989a). The approach is very conservative and likely to overestimate the true cancer risks associated with exposure to the chemicals of concern. Risk estimates are compared with the USEPA's target risk range of 1×10^{-4} (1 in 10,000) to 1×10^{-6} (1 in 1,000,000) incremental excess lifetime cancer risk (USEPA 1990).

5.2 SUMMARY OF POTENTIAL NONCARCINOGENIC HEALTH HAZARD AND CANCER RISKS

The calculation of individual HQs and cancer risks for each receptor, exposure route and compound are presented in Attachment A and are summarized in Tables 5-1 (current site use) and 5-2 (future site use).

Both average exposure and RME hazard indices are less than the threshold value of 1.0 for all exposure scenarios and stream segments evaluated in this RA. This indicates that surface water and sediment in both West and East Soldier Creeks should not pose a noncarcinogenic health hazard to any on-Base or off-Base populations under current or future stream use conditions.

As shown on Tables 5-1 and 5-2, potential cancer risks associated with all scenarios are less than the baseline risk level of 10^{-4} established by USEPA for identifying sites that require remedial action (USEPA 1991c). These results indicate that exposure to surface water and sediment in West and East Soldier Creeks is not likely to result in an unacceptable cancer risk for any on-Base or off-Base populations under current or future stream use conditions.

Lead was not included in the quantitative risk evaluation because a CTV is not available for lead. Lead was retained as a COPC for the on-Base East Soldier Creek sediment because the maximum detected concentration of lead exceeded the residential lead soil screening level of 400 mg/kg. However, the RME and average lead exposure point concentrations were below the residential lead soil screening level. Additionally, this residential soil screening level is based on a greater exposure frequency than is likely to occur for exposure to sediment.

TABLES

TABLE 5-1

NONCARCINOGENIC HEALTH HAZARDS AND CARCINOGENIC RISKS ASSOCIATED WITH SURFACE WATER AND SEDIMENT IN SOLDIER CREEK (CURRENT SCENARIO)

	ON-BASE WORKER				OFF-BASE RESIDENT [a]			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	0.0005	8E-10	0.002	7E-09
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	0.002	1E-08	0.02	2E-07
SEDIMENT INGESTION[b]	NA	NA	NA	NA	0.04	7E-07	0.2	5E-06
SEDIMENTS DERMAL EXPOSURE[b]	NA	NA	NA	NA	0.009	2E-07	0.08	2E-06
TOTAL	NA	NA	NA	NA	0.06	9E-07	0.3	7E-06
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0000085	5E-11	0.0003	5E-09	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	0.0002	1E-09	0.02	3E-07	NA	NA	NA	NA
SEDIMENT INGESTION[b]	0.0003	9E-10	0.02	4E-07	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE[b]	0.0002	9E-10	0.1	2E-06	NA	NA	NA	NA
TOTAL	0.0007	3E-09	0.1	3E-06	NA	NA	NA	NA
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	0.0007	0E+00	0.004	0E+00
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	0.01	0E+00	0.04	0E+00
SEDIMENT INGESTION[b]	NA	NA	NA	NA	0.01	1E-08	0.05	6E-08
SEDIMENTS DERMAL EXPOSURE[b]	NA	NA	NA	NA	0.007	6E-09	0.1	7E-08
TOTAL	NA	NA	NA	NA	0.03	2E-08	0.2	1E-07

Note:

a. The hazard indices or cancer risk associated with both adult and child resident

b. Surface (0-0.5 feet) sediments data are used in the calculations.

TABLE 5-2

NONCARCINOGENIC HEALTH HAZARDS AND CARCINOGENIC RISKS ASSOCIATED WITH SURFACE WATER AND SEDIMENT IN SOLDIER CREEK (FUTURE SCENARIO)

	ON-BASE WORKER				OFF-BASE RESIDENT [a]			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	0.0005	8E-10	0.002	7E-09
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	0.002	1E-08	0.02	2E-07
SEDIMENT INGESTION[b]	NA	NA	NA	NA	0.04	7E-07	0.2	5E-06
SEDIMENTS DERMAL EXPOSURE[b]	NA	NA	NA	NA	0.009	2E-07	0.08	2E-06
TOTAL	NA	NA	NA	NA	0.06	9E-07	0.3	7E-06
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0000085	5E-11	0.0003	5E-09	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	0.0002	1E-09	0.02	3E-07	NA	NA	NA	NA
SEDIMENT INGESTION[c]	0.0004	2E-09	0.02	6E-07	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE[c]	0.0002	2E-09	0.08	3E-06	NA	NA	NA	NA
TOTAL	0.001	6E-09	0.1	4E-06	NA	NA	NA	NA
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	0.0007	0E+00	0.004	0E+00
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	0.01	0E+00	0.04	0E+00
SEDIMENT INGESTION[c]	NA	NA	NA	NA	0.005	2E-08	0.04	1E-07
SEDIMENTS DERMAL EXPOSURE[c]	NA	NA	NA	NA	0.004	1E-08	0.08	1E-07
TOTAL	NA	NA	NA	NA	0.02	3E-08	0.2	2E-07

Note:

a. The hazard indices or cancer risk associated with both adult and child resident

b. Surface (0-0.5 feet) sediments data are used in the calculations because only surface samples were collected.

c. Sediment data collected from all depths are used in the calculations.

6.0 REMEDIAL ACTION OBJECTIVES

The establishment of health-based Remedial Action Objectives (RAOs) (i.e., "cleanup goals") serves as an important means of guiding remedial activities. In general, the development of health-based RAOs is warranted whenever a site is found to pose an unacceptable risk to either human health or the environment, and "cleanup" standards promulgated by state or federal agencies are not available. The approach used to develop health-based cleanup goals is derived from the RA process. A human health-based cleanup goal is established by "back-calculating" a health protective contaminant concentration, given a target risk which is deemed acceptable, and using realistic intake factors to represent potentially exposed populations.

Although there were no constituents found in Soldier Creek surface water or sediment that posed an unacceptable risk to human health, human-health based cleanup goals were calculated for the COPCs. The approach used to develop cleanup goals in this document was the same as the approach used in the previous RAs (WCFS 1996, 1997b, 1997c) and incorporates RME assumptions and reasonable site use scenarios so that residual risks posed by the site after corrective action are within a health-protective range. It is important to note that since the RME is meant to represent the most exposed individual in a population, the RAOs are conservative. Because cleanup goals developed using RME assumptions are health-protective of the most exposed individual in a population, they will be health-protective for all potentially exposed individuals within that population.

RAOs were calculated using the most conservative exposure scenario, (i.e., the scenario associated with the largest risk or hazard). For COPCs found off-Base, the largest risks and hazards were associated with residential exposure scenarios. For COPCs found only in the on-Base portions of the creek, the construction worker scenario is the only applicable scenario, and thus was used to calculate RAOs.

Human health RAOs were calculated based on both the carcinogenic and noncarcinogenic properties of the COPCs. For carcinogens, RAOs were calculated based on target risk levels of 10^{-6} (one in a million), 10^{-5} (one in one hundred thousand), and 10^{-4} (one in ten thousand). These three values encompass the acceptable risk range of 10^{-6} to 10^{-4} identified by USEPA. For noncarcinogens, RAOs were calculated based on a target Hazard Index of 1.0. The equations used to calculate RAOs are presented below. These equations were used by WCFS (1996, 1997b, 1997c) and were used here to preserve continuity between the RAs previously prepared by WCFS and this RA.

For carcinogens:

RAO = (Risk Assessment Concentration/Calculated Risk) (Target Risk)

For noncarcinogens:

RAO = (Risk Assessment Concentration/Calculated Hazard) (Target Hazard)

Where

Risk Assessment Concentration = The maximum chemical exposure point concentration used in the RA

Calculated Risk = The highest calculated risk associated with the exposure point concentration

Target Risk = 10^{-6}, 10^{-5}, and 10^{-4}

Calculated Hazard = The highest calculated hazard associated with the exposure point concentration

Target Hazard = 1.0

The RAOs for COPCs in sediment are summarized in Table 6-1. For chemicals with both carcinogenic and noncarcinogenic RAOs, the lower level of these values is the health-protective value. Because surface water in the creek is a dynamic medium that is constantly changing, it is inappropriate to develop RAOs for chemicals in the surface water. However, by using the same approach in calculating the RAOs, health-based indicators of water quality were developed for chemicals in surface water and are summarized in Table 6-2. Additionally, the Water Quality Standards (see Section 2.2.3) would be Applicable or Relevant and Appropriate Requirements (ARARs) for surface water.

TABLES

TABLE 6-1
RISK-BASED CLEANUP LEVELS
FOR CHEMICALS IN SEDIMENT

Chemical	RME[a] (mg/kg)	Dermal HQ	Ingestion HQ	Total HQ[b]	Dermal Cancer Risk	Ingestion Cancer Risk	Total Cancer Risk	Noncarcinogenic Action Level[c] (mg/kg)	Carcinogenic Action Level[d] (Risk = 1 x 10-6) (mg/kg)	Carcinogenic Action Level[d] (Risk = 1 x 10-5) (mg/kg)	Carcinogenic Action Level[d] (Risk = 1 x 10-4) (mg/kg)
Aldrin[f]	1.10E-01	1.41E-04	3.59E-05	1.77E-04	2.56E-08	6.53E-09	3.22E-08	6.23E+02	3.42E+00	3.42E+01	3.42E+02
Antimony[f]	4.61E+00	1.10E-03	1.13E-04	1.22E-03				3.79E+03			
Arsenic	1.22E+01	8.00E-04	9.01E-03	9.81E-03	1.54E-07	1.74E-06	1.89E-06	1.24E+03	6.45E+00	6.45E+01	6.45E+02
Aroclor 1254[f]	1.30E+01	1.39E-02	6.36E-03	2.02E-02	1.98E-07	9.09E-08	2.89E-07	6.43E+02	4.50E+01	4.50E+02	4.50E+03
Barium	4.55E+03	7.49E-03	1.44E-02	2.19E-02				2.08E+05			
Benzidine[f]	9.40E-02	7.51E-07	3.07E-07	1.06E-06	1.85E-07	7.56E-08	2.61E-07	8.89E+04	3.60E-01	3.60E+00	3.60E+01
Benzo(a)anthracene[f]	9.39E+00				1.51E-07	2.40E-08	1.75E-07		5.35E+01	5.35E+02	5.35E+03
Benzo(a)pyrene	5.80E-01				4.72E-07	4.02E-07	8.74E-07		6.64E-01	6.64E+00	6.64E+01
Benzo(b)fluoranthene[f]	1.00E+01				1.62E-07	2.56E-08	1.87E-07		5.35E+01	5.35E+02	5.35E+03
Benzo(k)fluoranthene[f]	8.38E+00				1.35E-08	2.14E-09	1.57E-08		5.35E+02	5.35E+03	5.35E+04
Cadmium	5.20E+01	4.19E-02	1.15E-02	5.34E-02				9.73E+02			
Chromium	2.69E+02	1.99E-02	3.52E-03	2.34E-02				1.15E+04			
Copper[f]	1.39E+03	2.22E-04	3.40E-04	5.62E-04				2.47E+06 [e]			
Dibenz(a,h)anthracene	1.80E-01				1.46E-07	1.25E-07	2.71E-07		6.64E-01	6.64E+00	6.64E+01
Indeno(1,2,3-cd)pyrene[f]	7.74E+00				1.25E-07	1.98E-08	1.45E-07		5.35E+01	5.35E+02	5.35E+03
Lead[f]	4.14E+02							NTV	NTV	NTV	NTV
Manganese[f]	1.11E+03	2.66E-03	5.43E-04	3.20E-03				3.46E+05			
Mercury[g]	1.20E+00	2.56E-05	1.17E-04	1.43E-04				8.39E+03			
Molybdenum[f]	4.88E+01	4.93E-05	9.56E-05	1.45E-04				3.37E+05			
Nickel[f]	8.71E+02	3.09E-04	4.26E-04	7.35E-04				1.18E+06 [e]			
Silver[f]	9.89E+00	2.11E-05	1.31E-04	1.52E-04				6.51E+04			
Thallium	4.31E+01	3.31E-02	1.36E-01	1.70E-01				2.54E+02			
Vanadium[f]	4.16E+01	5.82E-05	7.83E-05	1.36E-04				3.05E+05			

Note: a) RME = Reasonable Maximum Exposure Concentration.
b) HQ = Hazard Quotient
c) Cleanup level = (Risk Assessment Conc/HQ) x HI where HI = 1.0
d) Cleanup level = (Risk Assessment Conc/Cancer risk) x Target cancer Risk
e) Calculated cleanup level is greater than 100% concentration and 100% concentration is assigned as the cleanup level.
f) Cleanup level based on worker scenario, constituent was not retained as a COPC in off-Base sediment.
g) Based on toxicity of methylmercury.
NTV = No published toxicity values; therefore, risk-based cleanup levels could not be calculated.

TABLE 6-2

RISK-BASED INDICATORS FOR CHEMICALS IN SURFACE WATER

Chemical	RME[(a)] (mg/L)	Ingestion HQ	Dermal HQ	Total HQ[(b)]	Ingestion Cancer Risk	Dermal Cancer Risk	Total Cancer Risk	Noncarcinogenic[(c)] Clean-up Level (mg/L)	Carcinogenic[(d)] Clean-up Level (Risk = 1 x 10^{-6}) (mg/L)	Carcinogenic[(c)] Clean-up Level (Risk = 1 x 10^{-5}) (mg/L)	Carcinogenic[(d)] Clean-up Level (Risk = 1 x 10^{-4}) (mg/L)
Acetone	3.20E-03	9.97E-06	NA	9.97E-06				3.21E+02			
Beryllium[e]	6.80E-05	5.32E-07	5.22E-05	5.27E-05				1.29E+00			
bis(2-ethylhexyl)phthalate[e]	3.60E-03	5.61E-05	1.34E-03	1.40E-03	6.73E-09	1.61E-07	1.68E-07	2.58E+00	2.15E-02	2.15E-01	2.15E+00
Cadmium	2.70E-03	1.68E-03	2.31E-02	2.48E-02				1.09E-01			
Chromium	1.20E-02	1.25E-03	8.57E-03	9.82E-03				1.22E+00			
Cobalt	2.70E-04	1.40E-06	9.64E-08	1.50E-06				1.80E+02			
Copper[e]	1.02E-01	3.99E-05	1.30E-04	1.70E-04				5.99E+02			
Dieldrin[e]	2.90E-05	9.08E-06	2.85E-04	2.94E-04	2.59E-09	8.14E-08	8.40E-08	9.87E-02	3.45E-04	3.45E-03	3.45E-02
Heptachlor[e]	2.40E-05	7.51E-07	1.13E-05	1.20E-05	6.04E-10	9.04E-09	9.64E-09	2.00E+00	2.49E-03	2.49E-02	2.49E-01
Molybdenum	3.50E-03	2.18E-04	7.89E-05	2.97E-04				1.18E+01			
Selenium	3.90E-03	2.43E-04	7.60E-05	3.19E-04				1.22E+01			
Silver	8.10E-05	5.05E-06	2.31E-06	7.36E-06				1.10E+01			
Tetrachloroethene[e]	1.50E-03	2.35E-06	NA	2.35E-06	4.36E-10	NA	4.36E-10	6.39E+02	3.44E+00	3.44E+01	3.44E+02
Vanadium	4.90E-03	5.48E-06	1.07E-05	1.62E-05				3.03E+02			

Note: a) RME = Reasonable Maximum Exposure concentration
b) HQ = Hazard Quotient
c) Cleanup level = (Risk Assessment Conc/HQ) x HI where HI = 1.0
d) Cleanup level = (Risk Assessment Conc/Cancer risk) x Target Cancer Risk
NA = Not Applicable. Due to their volatility, volatile organics are not assumed available for dermal absorption.
e) Cleanup level based on worker scenario, constituent was not retained as a COPC in off-Base surface water.

7.0
UNCERTAINTY ANALYSIS

The risk measures used in risk assessments are not fully probabilistic estimates of risk but are conditional estimates given that a set of assumptions about exposure and toxicity are realized. There are a number of uncertainties and limitations inherent in the risk assessment process. The uncertainties can lead to an over- or underestimation of the risk. It is important to specify the assumptions and uncertainties to place the risk estimates in proper perspective (EPA, 1989a).

A qualitative analysis of each of the risk assessment components is sufficient for most sites. Table 7-1 presents a qualitative assessment of the factors that may contribute to uncertainty in the estimation of potential risks for East and West Soldier Creeks at Tinker AFB. Available data quality, incomplete information about existing conditions and future circumstances, as well as other factors discussed below contribute to these uncertainties and limitations. The uncertainties associated with the steps of the risk assessment are discussed below.

7.1 DATA COLLECTION AND EVALUATION

7.1.1 Data Collection

Data used in this RA were collected from East and West Soldier Creeks during two semi-annual sampling events that are part of the long-term monitoring of Soldier Creek. These data are subject to uncertainty associated with sampling and analysis.

7.1.1.1 Sampling

It was assumed that the samples collected were representative of areas where various populations may be exposed. However, collected samples may not be completely representative due to biases in sampling, random variability, or sources of non-random variation. Concentrations in sediment and surface water may vary due to the annual precipitation cycle or periodic releases from on-Base or off-Base outfalls. These sources of bias or variability may result in either an over- or underestimation of actual chemical concentrations, and subsequently, site risks.

7.1.1.2 Analysis

The laboratory followed appropriate quality assurance (QA) procedures to ensure that the data were suitable for use in decision-making. However, it should be understood that sample analysis is subject to uncertainties associated with precision and accuracy. Uncertainties associated with precision and accuracy of analysis are generally random. While these errors are typically of low magnitude compared to other sources of uncertainty in the RA, they may lead to a possible over- or underestimation of risk.

Twenty percent of the data used in the risk assessment was fully validated. Validation procedures followed the guidance outlined in the Quality Assurance Project Plan (WCFS, 1994).

7.1.2 Data Evaluation

The general assumptions used in the COPC selection process are conservative to ensure the estimation of highest possible risk. The use of USEPA Region III residential soil ingestion RBCs as screening concentrations for sediment is extremely conservative since it is not likely that exposure to sediment would be as frequent as exposure to soil. The use of AWQC for the ingestion of fish and water is also extremely conservative since Soldier Creek does not have a viable fish population and surface water from Soldier Creek is not used as a potable water supply.

In accordance with USEPA guidance, several inorganic chemicals present at background concentrations were removed from consideration as potential COPCs because they are not site-related contaminants. This exclusion process was not extended to organic chemicals, because it is difficult to establish true background levels for most organics. Nonetheless, it is likely that some of the organic chemicals identified as COPCs are present at background levels, and are not site-related contaminants. Inclusion of these chemicals in the risk calculations will result in an overestimation of site-related risks.

The COPC selection process used for this RA was updated to be more consistent with current RA methodology and is not completely consistent with the methodology used in the previous RAs conducted by WCFS (1996, 1997b, 1997c). This results in selection of different

COPCs, which may alter the results of the risk assessment from what they would have been using the original methodology.

7.2 EXPOSURE ASSESSMENT

The exposure assessment is based on a series of assumptions concerning concentrations of chemicals to which humans are exposed (exposure point concentrations) and patterns of behavior leading to exposure or intake of chemicals (exposure scenarios). These assumptions generally reflect worst-case or upper-bound assumptions on the exposure.

7.2.1 Exposure Point Concentrations

The arithmetic mean concentrations and 95th percent UCL on the mean concentrations were calculated for COPCs in each medium. The 95th percent UCL concentrations were used to estimate risk for RME exposure scenarios (except if it was greater than the maximum concentration, in which case the maximum concentration was used as the exposure concentration). Because UCL concentrations are high end values, typically closer to maximum concentrations than to the arithmetic mean concentrations, use of UCL concentrations in the RA will likely result in an overestimation of potential risk.

It was conservatively assumed that the chemical concentrations observed during the 1998 sampling events would remain unchanged with time. The potential reductions in chemical concentrations by remedial action, migration, degradation, or attenuation were not considered in the RA. The use of existing chemical concentrations projected into the future may result in an overestimation of potential health risks. However, the assessment also did not take into consideration that any of the degradation products may be more toxic than the parent compounds currently detected. If this were to occur, the RA may underestimate the future risk.

When calculating exposure point concentrations it was assumed that a chemical not detected in a given sample was present at one-half of its detection limit, if that chemical was present in any sample from that medium and stream segment. This approach, as described in the RAGS (USEPA 1989a), is a conservative approach that is likely to lead to an overestimation of risk, particularly when the quantification limits are high (due to interferences or sample dilution during analysis) or the only measured concentrations are "J" coded values less than the detection limits.

The use of statistical methods to calculate exposure point concentrations can result in calculated concentrations that exceed the maximum measured concentrations, particularly when the sample size is small and the standard deviation of the results is large. Use of a statistical approach to calculate exposure point concentrations when the sample size is small or standard deviation is large is likely to result in an overestimation of risk.

7.2.2 Exposure Scenarios

The exposure assessment relied on a number of assumptions for potential human exposure. The majority of the parameter values used in this assessment were the values used in the three previous RAs. The only parameter value that was not the same was the incidental ingestion rate of surface water while wading. The value used for this RA was higher than the value used for the previous RAs. The exposure assumptions were based on:

- Site-specific information (including information provided in the Baseline Risk Assessments [B&V 1993 and WCFS 1996c])

- RAGS (USEPA 1989a), the *Exposure Factors Handbook* (USEPA 1989b), *USEPA Region IV Supplemental Risk Assessment Guidance* (USEPA 1996), and *Dermal Exposure Assessment: Principles and Applications* (USEPA 1992a)

- Professional judgment

The average case scenarios represent assumptions that are considered central values, or realistically conservative estimates for the exposed population. However, even the average case exposure scenario is conservative because it assumes individuals are exposed on a regular basis over a long period of time and, therefore, is likely to overestimate risk. RME scenarios are developed to provide an upper bound risk estimate. The RME scenarios are based upon a combination of conservative assumptions for all variables related to exposure and, therefore, are highly likely to overestimate potential risks.

In some cases (e.g., the dermal permeability constants), published information for one chemical has been assumed to be representative of other related chemicals. These assumptions may lead to over- or underestimation of risk. The general approach used in this assessment was to use conservative assumptions for intake variables in the absence of strong scientific data, thus minimizing the likelihood that risks are underestimated.

Dermal absorption of VOCs from surface water was not evaluated in this RA since it was not evaluated in the previous RAs. It was assumed that VOCs would volatilize from the skin surface before they could be absorbed. This may result in a slight underestimation of potential risks.

7.3 TOXICITY ASSESSMENT

7.3.1 Critical Toxicity Values

In general, the available scientific information is insufficient to provide a thorough understanding of all the potential toxic properties of chemicals to which humans are potentially exposed. Consequently, varying degrees of uncertainty surround the assessment of adverse health effects among exposed populations. Sources of uncertainty related directly to toxicity data include:

- Use of dose-response data from experiments on homogenous, sensitive animal populations to predict effects in heterogeneous human populations with a wide range of sensitivities

- Extrapolation of data from: 1) high dose animal studies to low dose human exposures; 2) acute or subchronic exposure; and 3) one exposure route to another (e.g., from ingestion to inhalation or dermal absorption)

- Use of single-chemical test data that does not account for multiple exposures or synergistic and antagonistic responses

- Critical toxicity values (RfDs or SFs) are predicted values for the most sensitive subpopulations

A high degree of overall uncertainty may be associated with the Critical Toxicity Values used in the RA because there are numerous potential sources of uncertainty associated with the basic toxicology data. In an attempt to minimize the consequences of uncertainty, USEPA guidance typically relies on a conservative approach, applying numerous safety factors to the toxicity data to insure the Critical Toxicity Values used in the RA are protective of all sensitive human populations. Therefore, use of these critical toxicity values is highly likely to overestimate potential risk.

SFs are based primarily on the results of animal studies. There is uncertainty whether all animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a certain number of chemical substances are known to be human carcinogens. The EPA assumes that humans are as sensitive to all animal carcinogens as the most sensitive animal species. This policy decision is designed to prevent underestimating risk and most likely overestimates carcinogenic risk.

The CTVs used in the previous RAs were updated to reflect current CTVs from EPA's IRIS (USEPA 1998) and HEAST (USEPA 1997) databases and other available toxicity information (i.e., USEPA Region III's Risk-Based Concentration Table). Therefore, the results of this current RA are not completely comparable with the results from the three previous RAs.

7.3.2 Derivation of Dermal Toxicity Values

Dermal toxicity values were derived from oral CTVs using chemical-specific GI absorption factors. Ideally, the GI absorption factors from the study used to derive the oral CTV would be used to adjust the oral CTV to a dermal CTV. This is not always possible, and GI factors published by the Oak Ridge National Laboratory (Bast and Borges, 1996) were used to derive dermal CTVs. There is a large degree of uncertainty associated with these GI factors which may result in an under- or overestimation of risk.

7.4 RISK CHARACTERIZATION

Because there are uncertainties in each step of the risk assessment process, uncertainties are often magnified in the final risk characterization. The final quantitative estimates of risk may be several orders of magnitude different from the potential risk associated with the given exposure. Because of the conservative approaches used in each step, the overall results of the RA are more likely to overestimate than underestimate the potential risk associated with contaminants in Soldier Creek.

7.5 REMEDIAL ACTION OBJECTIVES

Remedial action objectives were developed for the COPCs using exposure assumptions developed in the exposure assessment and CTVs identified in the toxicity assessment. All of the uncertainties associated with selection of COPCs, development of exposure assumptions, and use of USEPA-derived toxicity values also apply to the calculation of remedial action objectives. Because of the inherent conservatism within the risk assessment process, the resulting remedial action objectives are likely to be conservative.

TABLES

TABLE 7-1

SUMMARY OF UNCERTAINTIES ASSOCIATED WITH RISK ASSESSMENT FOR SOLDIER CREEK

Assumptions	Estimated Magnitude of Effect on Risk	Direction of Effect on Risk Estimate
Data Collection and Evaluation		
Samples collected were representative of conditions to which various populations may be exposed.	Low - Moderate	May over- or underestimate risk.
Errors in chemical analysis	Low	May over- or underestimate risk.
For chemicals without a risk-based screening value, a surrogate compound was identified and its risk-based screening was used to determine if these chemicals were COPCs.	Low	May over- or underestimate risk.
Exposure Assessment		
Use of existing chemical concentrations projected into the future	Low - Moderate	May overestimate site-related risks.
Not considering degradation products which may be more toxic than the parent compound.	Low	May underestimate risk.
One-half the detection limit was used as the concentration for chemical concentrations reported as "below method detection limit" when calculating the exposure point concentration.	Low - Moderate	May over- or underestimate risk, but usually overestimate risk.
For RME exposure scenarios, the 95th percentile UCL concentrations were used to estimate risk.	Low - Moderate	Likely result in an overestimate of risk.
Use combination of conservative assumptions to estimate RME associated risks.	Moderate	May overestimate risk.
Toxicity Assessment		
The use of conservative USEPA models for developing Slope Factors (SF)	Moderate - High	May overestimate risk.
The Reference Dose (RfD) for a compound is an estimate of the threshold concentration for the most sensitive human population associated with the lowest observed adverse effect for that compound	Moderate - High	May overestimate risk.
Critical toxicity values weren't available for two of the identified COPCs and appropriate surrogates could not be identified. Therefore, these chemicals couldn't be evaluated in the quantitative risk assessment.	Low - Moderate	May underestimate risk.
Use of gastrointestinal absorption factor to adjust oral CTVs to dermal CTVs.	High	May over- or underestimate risk.
Risk Characterization		
Conservative approaches used in each step	Moderate - High	May overestimate risk.
Hazard indices and total incremental carcinogenic risks were developed assuming hazards and risks were additive, and did not account for synergestic or antagonistic releationships.	Moderate	May over- or underestimate risk.
Remedial Action Objectives		
All the uncertainties associated with COPC selection, exposure assumption development, and EPA-derived toxicity values.	Moderate - High	Likely to be overly conservative.

8.0 TRENDS

Contaminants and their concentrations are continuously changing along the length of Soldier Creek and its tributaries. Because of the dynamics of the Soldier Creek system, the results of the first, second, and third year RAs (WCFS 1996, 1997b, 1997c) were compared to the results of this current risk assessment to evaluate any trends that may be occurring. Although the fourth year RA was compared with the previous RAs, it should be noted that it is not completely comparable to the three previous RAs. The COPC selection process and CTVs have been updated to reflect current human health RA methodology and values and most likely result in differences in the risk assessment results.

Tables 8-1 and 8-2 show the comparison of first year, second year, third year, and fourth year noncarcinogenic health hazards and carcinogenic risks from surface water and sediment for on-Base workers under the current and future use scenarios, respectively.

Tables 8-3 and 8-4 show the comparison of first year, second year, third year, and fourth year off-Base resident noncarcinogenic health hazards and carcinogenic risks from exposure to surface water and sediment under current and future use scenarios, respectively.

8.1 ON-BASE WEST SOLDIER CREEK

On-Base West Soldier Creek is currently undergoing remediation. Therefore, human health risks were not evaluated for on-Base West Soldier Creek for this fourth year RA. The results from the three previous RAs are included on Tables 8-1 and 8-2. Trends in the risk assessment results were discussed in the third year RA (WCFS 1997c).

8.2 OFF-BASE WEST SOLDIER CREEK

The off-Base residential HIs for this segment of Soldier Creek were approximately one order of magnitude higher in the second, third, and fourth year RAs than in the first year RA (Tables 8-3 and 8-4). The HIs calculated for the fourth year were slightly higher than the second and third year HIs, but were within the same order of magnitude. Potential estimated off-Base residential cancer risks were within an order of magnitude for all four years. The potential risks were slightly higher for the third and fourth year RAs than the first and second year RAs (Tables 8-3 and 8-4). The dynamics of the creek system resulted in different COPC lists and concentrations between the four years, which resulted in different potential risks.

Sediment

Largely because a different COPC screening methodology was used, fewer chemicals were considered COPCs in the fourth year than the previous year. Many of the same inorganic and organic constituents were detected, but were not retained as COPCs. In the previous years there was no way to eliminate an organic constituent from the COPC list, however due to the different screening methodology, organics were eliminated from the list in the fourth year RA. Additionally, while similar PAHs were detected in the third and fourth year, the concentrations were lower in the fourth year. More pesticides were detected in the first year than in the second, third, and fourth years, and PAH concentrations were markedly higher in the third year than in the second year and fourth years. The current and future off-Base residential exposure scenarios for the second year RA indicated slightly higher estimated HIs and slightly lower cancer risks than were estimated in the first year RA. The third year HIs are similar to the second year HIs, but the cancer risks for the third year are higher than the first two years. The cancer risks for the fourth year were slightly lower than the risks for the third year but higher than the first two years. The HIs for the fourth year were slightly higher than the three previous years.

The cancer risks and noncarcinogenic health effects for all four RAs were primarily driven by ingestion of sediment. Aroclor 1254 was the major contributor to the HIs for the first three RAs and aroclor 1254 and thallium were the major contributors for the fourth year. Benzidine was the major carcinogenic contributor for the second year RA and PAHs were the major contributor in the first and third year RAs. Benzidine and arsenic were the major contributors to cancer risk in the fourth year.

Surface Water

More metals were considered as COPCs in the second and third year RAs than in the first year RA, and even more metals were considered COPCs in the fourth year. This is largely due to the different screening methodology used in the fourth year. Fewer volatiles were considered as COPCs in the second year RA than in the first and third year RAs, and none were considered COPCs in the fourth year.

A comparison of potential risks for off-Base West Soldier Creek surface water indicated that both the HIs and cancer risks were lower in the second year RA than were estimated in the first year RA. The third year HIs and cancer risks from surface water are in general lower than the first year and slightly higher than the second year. The fourth year HIs were greater than all the previous years HIs, and the cancer risks were similar to the first year cancer risks. The higher HIs in the fourth year may be associated with the larger number of inorganic COPCs, which may be the result of a different COPC screening process.

Dermal contact was the primary pathway of concern for surface water exposures. Metals were the major contributors to the HIs for all four RAs. Metals and bromomethane were the major contributors to the third year RA HIs. Arsenic was the major contributor to cancer risks in the first RA. No carcinogenic compounds were detected; therefore, there were no cancer risks from surface water for the second year RA along this creek segment. Chloromethane was the major contributor to the third year RA cancer risks, and bis(2-ethylhexy) phthalate was the only contributor to cancer risk in the fourth year RA.

8.3 ON-BASE EAST SOLDIER CREEK

In general, there are no significant changes in the potential HIs and cancer risks between the four RAs. The HIs have risen slightly from the first year. The RME HI in the fourth year was an order of magnitude greater than the previous HIs, however the average HI was similar to the HIs from the three previous years. The estimated cancer risks have decreased from the first year to the third year and then remained fairly constant between the third and the fourth year. These changes are likely due to the differences in detected COPCs and their concentrations.

Sediment

Fewer chemicals were considered COPCs in the second year than in the first year RA. More pesticides and metals were detected in the second and third years. Several SVOCs and aldrin were detected at significantly higher concentrations in the second year than in the first year. However, pesticides and SVOC concentrations (especially PAHs) were lower in the third year than in the second year. Pesticides and SVOC concentrations were higher in the fourth year than the third year. Fewer organic chemicals were considered COPCs in the fourth year than the previous years due to the change in COPC screening methodology.

For the current Base worker exposure scenarios, estimated HIs were slightly higher in the third year than in the second year. The RME HIs were even higher in the fourth year, however the average HIs did not increase from the third to the fourth year. Cancer risks were slightly lower in the third and fourth year RAs than in the second year RA. The cancer risks and noncarcinogenic health effects for the third year RA were primarily driven by ingestion (see Table 8-1). Second and fourth year RA cancer risks and noncarcinogenic health effects were primarily driven by dermal exposure. The first year RA noncarcinogenic health effects and cancer risks were driven by ingestion of sediment. Aroclor 1254 was the major contributor to the HI for the first and second year RAs. Thallium and Aroclor 1254 were the major contributors to HI for the third and fourth year RA. Benzidine and PAHs were the major contributors to the cancer risks for the first and second year RAs. PAHs and aroclor 1254 were the major contributors to the cancer risks for the third and fourth year RAs.

For the future Base worker exposure scenarios, third year estimated HIs were slightly higher and cancer risks were mostly lower than indicated in the first and second year RAs (see Table 8-2). Fourth year HIs were even higher than third year HIs, and fourth year cancer risks were similar to third year cancer risks. The noncarcinogenic health effects for the second, third, and fourth year RAs were primarily driven by ingestion of thallium and Aroclor 1254 in sediment. The cancer risks were primarily driven by dermal contact with Aroclor 1254 and PAHs. The cancer risks and noncarcinogenic health effects for the first year RA were primarily driven by dermal contact. Aroclor 1254, and benzidine and PAHs were the major contributors to the HI and cancer risks, respectively.

Surface Water

Bis(2-ethylhexyl) phthalate was the only SVOC considered to be a COPC in surface water for the third and fourth year RAs. More metals and SVOCs were considered COPCs in the second year than in the first year. No pesticides were considered COPCs in the 2nd year RA, however, pesticides were included in the first, third, and fourth year RAs. Aroclor 1254 was the only pesticide considered to be a COPC for the third year RA. Several different volatiles were considered COPCs in the second year RA than in the first year RA, and concentrations of recurring volatile COPCs were approximately two (2) times higher in the second year than those detected for the first year RA. In general, concentrations of volatile COPCs for the third and fourth year RAs were similar or slightly lower than the second year RA concentrations.

For the Base worker exposure scenarios, estimated potential cancer risks were slightly higher in the second year RA than those for the first, third, and fourth year RAs, and HIs were slightly lower in the second year RA.

The cancer risks and noncarcinogenic health effects were primarily driven by dermal contact in all four RAs. Metals were the major contributors to the HIs for the first and second year RAs. Metals (in particular cadmium) and bis(2-ethylhexyl)phthalate were the major contributors to the HI for the fourth year. Aroclor 1254 is the major contributor to the HI for the third year RA. Aroclor 1254 was also the major contributor to the cancer risks for the third year RA. Benzidine was the major carcinogenic contributor in the second year RA. Aldrin was the major contributor to the cancer risks in the first year RA. Bis(2-ethylhexyl)phthalate and dieldrin were the major contributors to cancer risks in the fourth year RA.

8.4 OFF-BASE EAST SOLDIER CREEK

Overall, the off-Base residential cancer risks for this segment of Soldier Creek were lower in the third year RA than in the first and second year RAs (see Tables 8-3 and 8-4). The off-Base residential cancer risks were even lower in the fourth year RA. HIs were higher in the third and fourth year RAs than in the second year RA. Creek dynamics, again, influenced the HIs and cancer risks by changing the COPCs and detected concentrations.

Sediment

Fewer SVOCs were considered COPCs in the third year RA than in the first and second year RAs, especially fewer PAHs (both carcinogenic and noncarcinogenic). Additionally, the detected concentrations of PAHs in the third year were significantly lower than in the first and second year RAs. While similar numbers and concentrations of SVOCs were detected in the fourth year, fewer were retained as COPCs based on the revised screening methodology.

For current and future off-Base residential exposure scenarios, the estimated cancer risks were lower in the third and fourth years than those estimated in the first and second year RAs (see Tables 8-3 and 8-4). HIs for the third year were slightly higher than the first and second year RAs. HIs for the fourth year were lower than the third year HIs.

Fourth year RA cancer risks and noncarcinogenic health effects were primarily driven by dermal contact with sediment for the RME evaluation and ingestion of sediment for the average evaluation. Third year RA cancer risks and noncarcinogenic health effects were primarily driven by ingestion of sediment. The inorganic COPCs (barium, cadmium, and chromium) contributed to the HI and the organic COPC (benzo(a)pyrene) contributed to the carcinogenic risk for the fourth year RA. Thallium and cadmium were the major contributors to the HI for the third year RA. Aroclor 1254 and cadmium were the major contributors to the HI for the first and second year RAs. Beryllium was the major contributor to the carcinogenic risks for the third year RA. Beryllium and benzo(a)pyrene were the major carcinogenic contributors for the second year RA. Pesticides were a major contributor to cancer risks in the first year RA.

Surface Water

Acetone was the only organic constituent detected during the fourth year monitoring and was the only organic COPC for the fourth year RA. Bis(2-ethylhexyl) phthalate was the only organic constituent considered to be a COPC for the third year RA. No pesticides/PCBs were considered to be COPCs for the third year. The detected pesticides and semivolatile organics considered to be COPCs in the second year RA were significantly different than those identified as COPCs in the first year RA.

Estimated HIs and cancer risks were slightly lower for dermal exposures to surface water in the third year than those indicated in the first and second year RAs. Fourth year dermal absorption HIs were greater than all previous year dermal absorption HIs. Ingestion HIs and cancer risks were higher in the third year RA than in the first, second, or fourth year RAs.

Ingestion of surface water was the primary driver for cancer risks and noncarcinogenic health effects in the first and third year RAs. The cancer risks and noncarcinogenic health effects were primarily driven by dermal contact in the second year RA. The noncarcinogenic health effects were driven by dermal contact in the fourth year RA. There were no carcinogenic COPCs in the fourth year, therefore carcinogenic risk was not evaluated and considered insignificant. Metals were the major contributors to the HI in the fourth year. Metals were the major contributors to the HI, and arsenic was the major carcinogenic risk contributor for the first and third year RAs. 4,4-DDT and 2,6-dichlorophenol were the major contributors to the second year HIs. 4,4-DDT was also the major carcinogenic contributor in the second year RA.

TABLES

TABLE 8-1
COMPARISON OF FIRST FOUR YEARS
HUMAN HEALTH RISKS ASSOCIATED WITH SOLDIER CREEK
CURRENT BASE WORKER SCENARIO

	ON-BASE WORKER (4th Year)				ON-BASE WORKER (3rd Year)			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
ON-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	0.00001	2E-10	0.0002	2E-08
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	0.00001	2E-10	0.0004	4E-08
SEDIMENT INGESTION	NA	NA	NA	NA	0.001	4E-10	0.02	2E-07
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	0.00003	1E-10	0.0080	4E-07
TOTAL	NA	NA	NA	NA	0.001	9E-10	0.03	7E-07
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0000085	5E-11	0.0003	5E-09	0.00002	1E-10	0.0003	1E-08
SURFACE WATER DERMAL EXPOSURE	0.0002	1E-09	0.02	3E-07	0.0003	5E-10	0.01	2E-07
SEDIMENT INGESTION	0.0003	9E-10	0.02	4E-07	0.0005	1E-09	0.03	5E-07
SEDIMENTS DERMAL EXPOSURE	0.0002	9E-10	0.1	2E-06	0.00003	4E-10	0.01	9E-07
TOTAL	0.0007	3E-09	0.1	3E-06	0.0008	2E-09	0.05	2E-06
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 8-1
COMPARISON OF FIRST FOUR YEARS
HUMAN HEALTH RISKS ASSOCIATED WITH SOLDIER CREEK
CURRENT BASE WORKER SCENARIO

	ON-BASE WORKER (2nd Year)				ON-BASE WORKER (1st Year)			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
ON-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	0.000002	1E-12	0.0001	2E-10	0.00001	5E-10	0.0002	6E-08
SURFACE WATER DERMAL EXPOSURE	0.000001	0E+00	0.0001	0E+00	0.000004	1E-09	0.0005	4E-07
SEDIMENT INGESTION	0.0004	3E-09	0.04	3E-07	0.0001	3E-08	0.01	5E-06
SEDIMENTS DERMAL EXPOSURE	0.0001	1E-09	0.06	7E-07	0.00002	1E-08	0.02	9E-06
TOTAL	0.0005	4E-09	0.1	1E-06	0.0001	4E-08	0.04	1E-05
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.000003	8E-09	0.0001	8E-07	0.00002	1E-10	0.001	2E-08
SURFACE WATER DERMAL EXPOSURE	0.00001	8E-09	0.0004	2E-06	0.00002	2E-10	0.002	2E-07
SEDIMENT INGESTION	0.0004	4E-09	0.02	7E-07	0.0002	1E-07	0.02	2E-05
SEDIMENTS DERMAL EXPOSURE	0.0001	1E-09	0.02	1E-06	0.0001	4E-08	0.01	3E-05
TOTAL	0.0005	2E-08	0.04	5E-06	0.0002	1E-07	0.03	4E-05
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA

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TABLE 8-2
COMPARISON OF FIRST FOUR YEARS
HUMAN HEALTH RISKS ASSOCIATED WITH SOLDIER CREEK
FUTURE BASE WORKER SCENARIO

	ON-BASE WORKER (4th Year)				ON-BASE WORKER (3rd Year)			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
ON-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	0.00001	2E-10	0.0002	2E-08
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	0.00001	2E-10	0.0004	4E-08
SEDIMENT INGESTION	NA	NA	NA	NA	0.001	2E-09	0.03	6E-07
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	0.000	7E-10	0.03	9E-07
TOTAL	NA	NA	NA	NA	0.001	3E-09	0.07	1E-06
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0000085	5E-11	0.0003	5E-09	0.00002	1E-10	0.0003	1E-08
SURFACE WATER DERMAL EXPOSURE	0.0002	1E-09	0.02	3E-07	0.0003	5E-10	0.01	2E-07
SEDIMENT INGESTION	0.0004	2E-09	0.02	6E-07	0.001	8E-10	0.02	3E-07
SEDIMENTS DERMAL EXPOSURE	0.0002	2E-09	0.08	3E-06	0.00004	3E-10	0.01	5E-07
TOTAL	0.001	6E-09	0.12	4E-06	0.001	2E-09	0.05	1E-06
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 8-2
COMPARISON OF FIRST FOUR YEARS
HUMAN HEALTH RISKS ASSOCIATED WITH SOLDIER CREEK
FUTURE BASE WORKER SCENARIO

	ON-BASE WORKER (2nd Year)				ON-BASE WORKER (1st Year)			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
ON-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	0.000002	1E-12	0.0001	2E-10	0.00001	5E-10	0.0002	6E-08
SURFACE WATER DERMAL EXPOSURE	0.000001	0E+00	0.0001	0E+00	0.000004	1E-09	0.0005	4E-07
SEDIMENT INGESTION	0.0004	5E-09	0.03	6E-07	0.0001	3E-09	0.01	4E-07
SEDIMENTS DERMAL EXPOSURE	0.0001	2E-09	0.04	1E-06	0.00002	1E-09	0.03	8E-07
TOTAL	0.0005	7E-09	0.07	2E-06	0.0001	6E-09	0.04	2E-06
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.000003	8E-09	0.0001	8E-07	0.00002	1E-10	0.001	2E-08
SURFACE WATER DERMAL EXPOSURE	0.00001	8E-09	0.0004	2E-06	0.00002	2E-10	0.002	2E-07
SEDIMENT INGESTION	0.0004	4E-09	0.01	6E-07	0.0001	8E-08	0.01	1E-05
SEDIMENTS DERMAL EXPOSURE	0.00004	2E-09	0.009	1E-06	0.00004	3E-08	0.01	2E-05
TOTAL	0.0005	2E-08	0.02	4E-06	0.0002	1E-07	0.02	3E-05
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 8-3
COMPARISON OF FIRST FOUR YEARS
HUMAN HEALTH RISKS ASSOCIATED WITH SOLDIER CREEK
CURRENT OFF-BASE RESIDENTIAL SCENARIO

	OFF-BASE RESIDENT (4th Year)				OFF-BASE RESIDENT 3rd Year)			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
ON-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0005	8E-10	0.002	7E-09	0.0001	1E-10	0.0003	8E-10
SURFACE WATER DERMAL EXPOSURE	0.002	1E-08	0.02	2E-07	0.0001	0E+00	0.0002	0E+00
SEDIMENT INGESTION	0.04	7E-07	0.2	5E-06	0.02	6E-07	0.1	9E-06
SEDIMENTS DERMAL EXPOSURE	0.009	2E-07	0.08	2E-06	0.001	2E-08	0.02	3E-06
TOTAL	0.06	9E-07	0.3	7E-06	0.02	6E-07	0.1	1E-05
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0007	0E+00	0.004	0E+00	0.001	6E-08	0.01	6E-07
SURFACE WATER DERMAL EXPOSURE	0.01	0E+00	0.04	0E+00	0.0005	3E-08	0.001	1E-07
SEDIMENT INGESTION	0.01	1E-08	0.05	6E-08	0.1	4E-08	0.4	3E-07
SEDIMENTS DERMAL EXPOSURE	0.007	6E-09	0.1	7E-08	0.001	7E-10	0.01	1E-08
TOTAL	0.03	2E-08	0.2	1E-07	0.1	1E-07	0.4	1E-06

TABLE 8-3
COMPARISON OF FIRST FOUR YEARS
HUMAN HEALTH RISKS ASSOCIATED WITH SOLDIER CREEK
CURRENT OFF-BASE RESIDENTIAL SCENARIO

	OFF-BASE RESIDENT 2nd Year)				OFF-BASE RESIDENT (1st Year)			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
ON-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	0.00001	0E+00	0.0002	0E+00	0.0001	5E-09	0.0002	4E-08
SURFACE WATER DERMAL EXPOSURE	0.00002	0E+00	0.0002	0E+00	0.0001	3E-09	0.001	5E-08
SEDIMENT INGESTION	0.02	3E-07	0.1	1E-06	0.01	2E-07	0.03	2E-06
SEDIMENTS DERMAL EXPOSURE	0.001	1E-08	0.02	4E-07	0.0002	6E-09	0.01	6E-07
TOTAL	0.02	3E-07	0.1	2E-06	0.01	2E-07	0.03	2E-06
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0004	3E-10	0.002	3E-09	0.002	5E-08	0.01	4E-07
SURFACE WATER DERMAL EXPOSURE	0.002	3E-08	0.005	2E-07	0.001	2E-08	0.002	1E-07
SEDIMENT INGESTION	0.003	1E-07	0.01	7E-07	0.01	3E-07	0.1	1E-06
SEDIMENTS DERMAL EXPOSURE	0.0001	1E-08	0.001	2E-07	0.0001	4E-08	0.002	3E-06
TOTAL	0.006	2E-07	0.02	1E-06	0.01	4E-07	0.2	5E-06

TABLE 8-4
COMPARISON OF FIRST FOUR YEARS
HUMAN HEALTH RISKS ASSOCIATED WITH SOLDIER CREEK
FUTURE OFF-BASE RESIDENTIAL SCENARIO

	OFF-BASE RESIDENT (4th Year)				OFF-BASE RESIDENT 3rd Year)			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
ON-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0005	8E-10	0.002	7E-09	0.0001	1E-10	0.0003	8E-10
SURFACE WATER DERMAL EXPOSURE	0.002	1E-08	0.02	2E-07	0.0001	0E+00	0.0002	0E+00
SEDIMENT INGESTION	0.04	7E-07	0.2	5E-06	0.02	6E-07	0.1	9E-06
SEDIMENTS DERMAL EXPOSURE	0.009	2E-07	0.08	2E-06	0.001	2E-08	0.02	3E-06
TOTAL	0.06	9E-07	0.3	7E-06	0.02	6E-07	0.1	1E-05
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0007	0E+00	0.004	0E+00	0.001	6E-08	0.01	6E-07
SURFACE WATER DERMAL EXPOSURE	0.01	0E+00	0.04	0E+00	0.0005	3E-08	0.001	1E-07
SEDIMENT INGESTION	0.005	2E-08	0.04	1E-07	0.1	4E-08	0.4	3E-07
SEDIMENTS DERMAL EXPOSURE	0.004	1E-08	0.08	1E-07	0.001	7E-10	0.01	1E-08
TOTAL	0.02	3E-08	0.2	2E-07	0.1	1E-07	0.4	1E-06

TABLE 8-4
COMPARISON OF FIRST FOUR YEARS
HUMAN HEALTH RISKS ASSOCIATED WITH SOLDIER CREEK
FUTURE OFF-BASE RESIDENTIAL SCENARIO

	OFF-BASE RESIDENT 2nd Year)				OFF-BASE RESIDENT (1st Year)			
	AVERAGE		RME		AVERAGE		RME	
	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
ON-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
OFF-BASE WEST SOLDIER CREEK								
SURFACE WATER INGESTION	0.00001	0E+00	0.0002	0E+00	0.0001	5E-09	0.0002	4E-08
SURFACE WATER DERMAL EXPOSURE	0.00002	0E+00	0.0002	0E+00	0.0001	3E-09	0.001	5E-08
SEDIMENT INGESTION	0.02	3E-07	0.1	1E-06	0.01	2E-07	0.03	2E-06
SEDIMENTS DERMAL EXPOSURE	0.001	1E-08	0.02	4E-07	0.0002	6E-09	0.01	6E-07
TOTAL	0.02	3E-07	0.1	2E-06	0.01	2E-07	0.03	2E-06
ON-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SURFACE WATER DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENT INGESTION	NA	NA	NA	NA	NA	NA	NA	NA
SEDIMENTS DERMAL EXPOSURE	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	NA	NA	NA	NA	NA	NA	NA	NA
OFF-BASE EAST SOLDIER CREEK								
SURFACE WATER INGESTION	0.0004	3E-10	0.002	3E-09	0.002	5E-08	0.01	4E-07
SURFACE WATER DERMAL EXPOSURE	0.002	3E-08	0.005	2E-07	0.001	2E-08	0.002	1E-07
SEDIMENT INGESTION	0.003	1E-07	0.01	7E-07	0.01	3E-07	0.1	1E-06
SEDIMENTS DERMAL EXPOSURE	0.0001	1E-08	0.001	2E-07	0.0001	4E-08	0.002	3E-06
TOTAL	0.006	2E-07	0.02	1E-06	0.01	4E-07	0.2	5E-06

9.0
SUMMARY AND CONCLUSION

This RA evaluated potential human health hazards (i.e., noncarcinogenic effects) and cancer risks associated with exposure to surface water and sediment from portions of East and West Soldier Creek that may have been impacted by contaminant releases from Tinker AFB. Based on differences in contaminant sources and exposed populations, the following three stream segments were evaluated quantitatively:

- West Soldier Creek, off-Base
- East Soldier Creek, on-Base
- East Soldier Creek, off-Base

Chemicals of concern were identified based on the evaluation of chemical data from surface water and sediment samples collected by CH2M HILL in the two semiannual sampling events of 1998. An evaluation of potential health risks was been performed for exposure scenarios believed to represent potential human activities that could occur in the three Soldier Creek segments. The exposure scenarios evaluated included:

- Construction workers involved in repair or installation of underground pipelines around or under on-Base portion of the creeks
- Residents wading or swimming in the off-Base portion of West and East Soldier Creeks

Swimming was only evaluated for the child scenario for East Soldier Creek; all other scenarios assumed wading only. Potential health risks were evaluated for exposure to surface water and sediment for on-site construction workers and off-site residents.

The results of the risk characterization demonstrate that potential cancer risks and noncarcinogenic health hazards for all scenarios are within or below the USEPA's targets of 10^{-6} to 10^{-4} and 1.0, respectively. These results indicate that exposure to surface water and sediment in West and East Soldier Creeks is not likely to result in an unacceptable cancer risk or noncarcinogenic hazard for any on-Base or off-Base populations under current or future stream use conditions.

As part of the RA, cleanup goals were developed to identify health-protective levels for each COPC. Although remediation does not appear to be warranted at the present time (based on risk to human health), these cleanup goals provide a set of "action criteria" should remedial action be required in the future.

A trend analysis was also done as part of this RA. The results of the comparison between this RA and the three previous RAs showed no dramatic changes and no significant trends.

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ATTACHMENT A
RISK CALCULATIONS

OFF-BASE WEST SOLDIER CREEK

TABLE A-1

TINKER AFB SITE - OFF-BASE WEST SOLDIER CREEK
INCIDENTAL INGESTION OF CHEMICALS IN SURFACE WATER DUE TO WADING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(CURRENT AND FUTURE USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	NON-CANCER HIF (L/kg-dy)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Oral RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER HIF (L/kg-dy)	CANCER CDI (mg/kg-dy)	CANCER Oral SF $(mg/kg\text{-}dy)^{-1}$	CANCER CANCER RISK (unitless)
Metals									
Cadmium	3.00E-04	8.29E-05	2.49E-08	5.00E-04	4.98E-05	1.66E-05	4.98E-09		
Chromium	6.88E-03	8.29E-05	5.70E-07	3.00E-03	1.90E-04	1.66E-05	1.14E-07		
Cobalt	1.60E-04	8.29E-05	1.33E-08	6.00E-02	2.21E-07	1.66E-05	2.65E-09		
Molybdenum	2.78E-03	8.29E-05	2.30E-07	5.00E-03	4.60E-05	1.66E-05	4.60E-08		
Selenium	9.05E-04	8.29E-05	7.50E-08	5.00E-03	1.50E-05	1.66E-05	1.50E-08		
Silver	8.10E-05	8.29E-05	6.72E-09	5.00E-03	1.34E-06	1.66E-05	1.34E-09		
Vanadium	1.23E-02	8.29E-05	1.02E-06	7.00E-03	1.45E-04	1.66E-05	2.03E-07		
Semivolatile Organics									
bis(2-Ethylhexyl)phthalate	3.60E-03	8.29E-05	2.99E-07	2.00E-02	1.49E-05	1.66E-05	5.97E-08	1.40E-02	8.36E-10
				HAZARD INDEX =	4.62E-04			TOTAL CANCER RISK =	8.36E-10

Equations

HIF = [(IRc x ETc x EFc x EDc) / BWc + (IRa x ETa x EFa x EDa) / BWa] / (CF x AT)
CDI = CW x HIF
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
HIF =	Human Intake Factor (L/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Calculated
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
IRc =	Child Ingestion Rate (L/hour)	0.025
ETc =	Child Exposure Time (hours/day)	3
EFc =	Child Exposure Frequency (days/year)	17
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
IRa =	Adult Ingestion Rate(L/hour)	0.005
ETa =	Adult Exposure Time (hour/day)	1
EFa =	Adult Exposure Frequency (days/year)	2
EDa =	Adult Exposure Duration (years)	9
BW =	Adult Body Weight (kg)	57.1
CF =	Conversion Factor (days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
Atnc =	Noncarcinogenic Averaging Time (years	14
SF =	Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-2

TINKER AFB SITE - OFF-BASE WEST SOLDIER CREEK
INCIDENTAL INGESTION OF CHEMICALS IN SURFACE WATER DUE TO WADING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(CURRENT AND FUTURE USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	NON-CANCER HIF (L/kg-dy)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Oral RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER HIF (L/kg-dy)	CANCER CDI (mg/kg-dy)	CANCER Oral SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals									
Cadmium	3.00E-04	3.12E-04	9.35E-08	5.00E-04	1.87E-04	1.34E-04	4.01E-08		
Chromium	1.20E-02	3.12E-04	3.74E-06	3.00E-03	1.25E-03	1.34E-04	1.60E-06		
Cobalt	1.60E-04	3.12E-04	4.99E-08	6.00E-02	8.31E-07	1.34E-04	2.14E-08		
Molybdenum	3.50E-03	3.12E-04	1.09E-06	5.00E-03	2.18E-04	1.34E-04	4.67E-07		
Selenium	1.10E-03	3.12E-04	3.43E-07	5.00E-03	6.86E-05	1.34E-04	1.47E-07		
Silver	8.10E-05	3.12E-04	2.52E-08	5.00E-03	5.05E-06	1.34E-04	1.08E-08		
Vanadium	1.40E-02	3.12E-04	4.36E-06	7.00E-03	6.23E-04	1.34E-04	1.87E-06		
Semivolatile Organics									
bis(2-Ethylhexyl)phthalate	3.60E-03	3.12E-04	1.12E-06	2.00E-02	5.61E-05	1.34E-04	4.81E-07	1.40E-02	6.73E-09
				HAZARD INDEX =	2.41E-03			TOTAL CANCER RISK =	6.73E-09

Equations

HIF = [(IRc x ETc x EFc x EDc) / BWc + (IRa x ETa x EFa x EDa) / BWa] / (AT x CF)
CDI = CW x HIF
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
HIF =	Human Intake Factor (L/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Calculated
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
IRc =	Child Ingestion Rate (L/hour)	0.05
ETc =	Child Exposure Time (hours/day)	6
EFc =	Child Exposure Frequency (days/year)	34
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
IRa =	Adult Ingestion Rate(L/hour)	0.01
ETa =	Adult Exposure Time (hour/day)	2
EFa =	Adult Exposure Frequency (days/year)	4
EDa =	Adult Exposure Duration (years)	25
BW =	Adult Body Weight (kg)	57.1
CF =	Conversion Factor (days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	30
SF =	Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-3

TINKER AFB SITE - OFF-BASE WEST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SURFACE WATER DUE TO WADING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(CURRENT AND FUTURE USE SCENARIO)

			NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	PC (cm/hr)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals										
Cadmium	3.00E-04	1.00E-03	6.12E-06	1.84E-09	5.00E-06	3.67E-04	1.22E-06	3.67E-10		
Chromium	6.88E-03	1.00E-03	6.12E-06	4.21E-08	6.00E-05	7.01E-04	1.22E-06	8.42E-09		
Cobalt	1.60E-04	4.00E-04	2.45E-06	3.92E-10	4.80E-02	8.16E-09	4.90E-07	7.84E-11		
Molybdenum	2.78E-03	1.00E-03	6.12E-06	1.70E-08	1.90E-03	8.94E-06	1.22E-06	3.40E-09		
Selenium	9.05E-04	1.00E-03	6.12E-06	5.54E-09	2.20E-03	2.52E-06	1.22E-06	1.11E-09		
Silver	8.10E-05	6.00E-04	3.67E-06	2.97E-10	9.00E-04	3.31E-07	7.35E-07	5.95E-11		
Vanadium	1.23E-02	1.00E-03	6.12E-06	7.50E-08	7.00E-05	1.07E-03	1.22E-06	1.50E-08		
Semivolatile Organics										
bis(2-Ethylhexyl)phthalate	3.60E-03	3.30E-02	2.02E-04	7.27E-07	3.80E-03	1.91E-04	4.04E-05	1.45E-07	7.37E-02	1.07E-08
					HAZARD INDEX =	2.34E-03			TOTAL CANCER RISK =	1.07E-08

Equations

HIF ={ [(SAc x ETc x EFc x EDc) / BWc + (SAa x ETa x EFa x EDa) / BWa] / (AT x CF2)} x CF1 x PC

CDI = CW x HIF

Hazard Quotient = CDI / RfD

Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
HIF =	Human Intake Factor (L/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Calculated
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
PC =	Chemical-specific Dermal Permeability Constant (cm/hour)	Chemical-specific
SAc =	Child Skin Surface Area Available for Contact (cm^2)	1,800
ETc =	Child Exposure Time (hours/day)	3
EFc =	Child Exposure Frequency (days/year)	17
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
SAa =	Adult Skin Surface Area Available for Contact (cm^2)	2,800
ETa =	Adult Exposure Time (hour /day)	1
EFa =	Adult Exposure Frequency (days/year)	2
EDa =	Adult Exposure Duration (years)	9
BW =	Adult Body Weight (kg)	57.1
CF1 =	Conversion Factor ($1L/1000cm^3$)	0.001
CF2 =	Conversion Factor (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	14
SF =	Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-4

TINKER AFB SITE - OFF-BASE WEST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SURFACE WATER DUE TO WADING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(CURRENT AND FUTURE USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	PC (cm/hr)	NON-CANCER HIF (L/kg-dy)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Dermal RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER HIF (L/kg-dy)	CANCER CDI (mg/kg-dy)	CANCER Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals										
Cadmium	3.00E-04	1.00E-03	4.29E-05	1.29E-08	5.00E-06	2.57E-03	1.84E-05	5.51E-09		
Chromium	1.20E-02	1.00E-03	4.29E-05	5.14E-07	6.00E-05	8.57E-03	1.84E-05	2.20E-07		
Cobalt	1.60E-04	4.00E-04	1.71E-05	2.74E-09	4.80E-02	5.71E-08	7.35E-06	1.18E-09		
Molybdenum	3.50E-03	1.00E-03	4.29E-05	1.50E-07	1.90E-03	7.89E-05	1.84E-05	6.43E-08		
Selenium	1.10E-03	1.00E-03	4.29E-05	4.71E-08	2.20E-03	2.14E-05	1.84E-05	2.02E-08		
Silver	8.10E-05	6.00E-04	2.57E-05	2.08E-09	9.00E-04	2.31E-06	1.10E-05	8.93E-10		
Vanadium	1.40E-02	1.00E-03	4.29E-05	6.00E-07	7.00E-05	8.57E-03	1.84E-05	2.57E-07		
Semivolatile Organics										
bis(2-Ethylhexyl)phthalate	3.60E-03	3.30E-02	1.41E-03	5.09E-06	3.80E-03	1.34E-03	6.06E-04	2.18E-06	7.37E-02	1.61E-07
					HAZARD INDEX =	2.12E-02			TOTAL CANCER RISK =	1.61E-07

Equations

HIF ={ [(SAc x ETc x EFc x EDc) / BWc + (SAa x ETa x EFa x EDa) / BWa] / (AT x CF2)} x CF1 x PC

CDI = CW x HIF

Hazard Quotient = CDI / RfD

Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
HIF =	Human Intake Factor (L/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Calculated
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
PC =	Chemical-specific Dermal Permeability Constant (cm/hour)	Chemical-specific
SAc =	Child Skin Surface Area Available for Contact (cm^2)	6,500
ETc =	Child Exposure Time (hours/day)	6
EFc =	Child Exposure Frequency (days/year)	34
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
SAa =	Adult Skin Surface Area Available for Contact (cm^2)	8,620
ETa =	Adult Exposure Time (hour /day)	2
EFa =	Adult Exposure Frequency (days/year)	4
EDa =	Adult Exposure Duration (years)	25
BW =	Adult Body Weight (kg)	57.1
CF1 =	Conversion Factor (1L/1000cm^3)	0.001
CF2 =	Conversion Factor (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	30
SF =	Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

ON-BASE EAST SOLDIER CREEK

TABLE A-5

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
INGESTION EXPOSURE TO CHEMICALS IN SURFACE WATER
ON-BASE CONSTRUCTION WORKER - AVERAGE EXPOSURE
(CURRENT AND FUTURE USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Oral RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER CDI (mg/kg-dy)	CANCER Oral SF (mg/kg-dy)-1	CANCER CANCER RISK (unitless)
Metals							
Beryllium	6.80E-05	5.32E-11	2.00E-03	2.66E-08	3.80E-12		
Cadmium	1.23E-03	9.63E-10	5.00E-04	1.93E-06	6.88E-11		
Chromium	9.88E-03	7.74E-09	3.00E-03	2.58E-06	5.53E-10		
Cobalt	2.08E-04	1.63E-10	6.00E-02	2.71E-09	1.16E-11		
Copper	5.46E-02	4.27E-08	4.00E-02	1.07E-06	3.05E-09		
Molybdenum	1.13E-03	8.85E-10	5.00E-03	1.77E-07	6.32E-11		
Selenium	8.78E-04	6.87E-10	5.00E-03	1.37E-07	4.91E-11		
Vanadium	1.33E-02	1.04E-08	7.00E-03	1.48E-06	7.42E-10		
Pesticides/PCBs							
Dieldrin	2.90E-05	2.27E-11	5.00E-05	4.54E-07	1.62E-12	1.60E+01	2.59E-11
Heptachlor	2.40E-05	1.88E-11	5.00E-04	3.76E-08	1.34E-12	4.50E+00	6.04E-12
Semivolatile Organics							
bis(2-Ethylhexyl)phthalate	1.22E-02	9.58E-09	2.00E-02	4.79E-07	6.84E-10	1.40E-02	9.58E-12
Volatile Organics							
Acetone	3.73E-03	2.92E-09	1.00E-01	2.92E-08	2.08E-10		
Tetrachloroethene	1.50E-03	1.17E-09	1.00E-02	1.17E-07	8.39E-11	5.20E-02	4.36E-12
			HAZARD INDEX=	8.52E-06		TOTAL CANCER RISK=	4.59E-11

Equations

CDI = (CW X IR X ET X EF X ED)/ (BW X AT X CF)
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
CDI =	Chronic Daily Intake (mg/kg-day)	Chemical-specific
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
IR =	Ingestion Rate(L/hour)	0.005
ET =	Exposure Time (hours/day)	4
EF =	Exposure Frequency (day/year)	1
ED =	Exposure Duration (years)	5
BW =	Body Weight (kg)	70
CF =	Coversion Factor (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	5
SF =	Slope Factor ((mg/kg-day)$^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-6

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
INGESTION EXPOSURE TO CHEMICALS IN SURFACE WATER
ON-BASE CONSTRUCTION WORKER - RME
(CURRENT AND FUTURE USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Oral RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER CDI (mg/kg-dy)	CANCER Oral SF (mg/kg-dy)-1	CANCER RISK (unitless)
Metals							
Beryllium	6.80E-05	1.06E-09	2.00E-03	5.32E-07	3.80E-10		
Cadmium	3.70E-03	5.79E-08	5.00E-04	1.16E-04	2.07E-08		
Chromium	1.29E-02	2.02E-07	3.00E-03	6.74E-05	7.22E-08		
Cobalt	2.61E-04	4.09E-09	6.00E-02	6.82E-08	1.46E-09		
Copper	1.02E-01	1.60E-06	4.00E-02	3.99E-05	5.70E-07		
Molybdenum	1.94E-03	3.04E-08	5.00E-03	6.09E-06	1.09E-08		
Selenium	1.20E-03	1.88E-08	5.00E-03	3.76E-06	6.71E-09		
Vanadium	1.37E-02	2.15E-07	7.00E-03	3.07E-05	7.66E-08		
Pesticides/PCBs							
Dieldrin	2.90E-05	4.54E-10	5.00E-05	9.08E-06	1.62E-10	1.60E+01	2.59E-09
Heptachlor	2.40E-05	3.76E-10	5.00E-04	7.51E-07	1.34E-10	4.50E+00	6.04E-10
Semivolatile Organics							
bis(2-Ethylhexyl)phthalate	1.30E-02	2.04E-07	2.00E-02	1.02E-05	7.28E-08	1.40E-02	1.02E-09
Volatile Organics							
Acetone	3.80E-03	5.95E-08	1.00E-01	5.95E-07	2.12E-08		
Tetrachloroethene	1.50E-03	2.35E-08	1.00E-02	2.35E-06	8.39E-09	5.20E-02	4.36E-10
			HAZARD INDEX =	2.87E-04		TOTAL CANCER RISK=	4.65E-09

Equations

CDI = (CW X IR X ET X EF X ED)/ (BW X AT X CF)
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
CDI =	Chronic Daily Intake (mg/kg-day)	Chemical-specific
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
IR =	Ingestion Rate(L/hour)	0.01
ET =	Exposure Time (hours/day)	8
EF =	Exposure Frequency (day/year)	5
ED =	Exposure Duration (years)	25
BW =	Body Weight (kg)	70
CF =	Coversion Factor (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	25
SF =	Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-7

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SURFACE WATER
ON-BASE CONSTRUCTION WORKER - AVERAGE EXPOSURE
(CURRENT AND FUTURE USE SCENARIOS)

CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	PC[a] (cm/hr)	NON-CANCER CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	CANCER CDI (mg/kg-dy)	Dermal SF (mg/kg-dy)-1	CANCER RISK (unitless)
Metals								
Beryllium	6.80E-05	1.00E-03	2.13E-11	2.00E-05	1.06E-06	1.52E-12		
Cadmium	1.23E-03	1.00E-03	3.85E-10	5.00E-06	7.71E-05	2.75E-11		
Chromium	9.88E-03	1.00E-03	3.09E-09	6.00E-05	5.16E-05	2.21E-10		
Cobalt	2.08E-04	4.00E-04	2.60E-11	4.80E-02	5.42E-10	1.86E-12		
Copper	5.46E-02	1.00E-03	1.71E-08	1.20E-02	1.42E-06	1.22E-09		
Molybdenum	1.13E-03	1.00E-03	3.54E-10	1.90E-03	1.86E-07	2.53E-11		
Selenium	8.78E-04	1.00E-03	2.75E-10	2.20E-03	1.25E-07	1.96E-11		
Vanadium	1.33E-02	1.00E-03	4.16E-09	7.00E-05	5.94E-05	2.97E-10		
Pesticides/PCBs								
Dieldrin	2.90E-05	1.60E-02	1.45E-10	2.50E-05	5.81E-06	1.04E-11	3.20E+01	3.32E-10
Heptachlor	2.40E-05	1.10E-02	8.27E-11	3.60E-04	2.30E-07	5.90E-12	6.25E+00	3.69E-11
Semivolatile Organics								
bis(2-Ethylhexyl)phthalate	1.22E-02	3.30E-02	1.26E-07	3.80E-03	3.33E-05	9.03E-09	7.37E-02	6.65E-10
Volatile Organics								
Acetone	3.73E-03			8.30E-02				
Tetrachloroethene	1.50E-03			1.00E-02			5.20E-02	
				HAZARD INDEX=	2.30E-04		TOTAL CANCER RISK=	1.03E-09

Note:
a. Volatile organics are assumed not available for dermal absorption.

Equations

CDI = (CW x SA x PC x ET x EF x ED x CF1)/(BW x AT x CF2)
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Value
CDI = Chronic Daily Intake (mg/kg-day)	Chemical-specific
CW = Concentration in Surface Water (mg/L)	Chemical-specific
SA = Skin Surface Area Available for Contact (cm^2)	2,000
PC = Chemical-specific Dermal Permeability Constant (cm/hour)	Chemical-specific
ET = Exposure Time (hours/day)	4
EF = Exposure Frequency (day/year)	1
ED = Exposure Duration (years)	5
CF1 = Volumetric Conversion Factor (0.001 L/cm^3)	0.001
BW = Body Weight (kg)	70
CF2 = Coversion Factor (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	5
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-8

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SURFACE WATER
ON-BASE CONSTRUCTION WORKER - RME
(CURRENT AND FUTURE USE SCENARIOS)

CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	PC[a] (cm/hr)	NON-CANCER CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	CANCER CDI (mg/kg-dy)	Dermal SF (mg/kg-dy)-1	CANCER RISK (unitless)
Metals								
Beryllium	6.80E-05	1.00E-03	1.04E-09	2.00E-05	5.22E-05	3.73E-10		
Cadmium	3.70E-03	1.00E-03	5.67E-08	5.00E-06	1.13E-02	2.03E-08		
Chromium	1.29E-02	1.00E-03	1.98E-07	6.00E-05	3.30E-03	7.07E-08		
Cobalt	2.61E-04	4.00E-04	1.60E-09	4.80E-02	3.34E-08	5.73E-10		
Copper	1.02E-01	1.00E-03	1.57E-06	1.20E-02	1.30E-04	5.59E-07		
Molybdenum	1.94E-03	1.00E-03	2.98E-08	1.90E-03	1.57E-05	1.07E-08		
Selenium	1.20E-03	1.00E-03	1.84E-08	2.20E-03	8.37E-06	6.58E-09		
Vanadium	1.37E-02	1.00E-03	2.10E-07	7.00E-05	3.00E-03	7.51E-08		
Pesticides/PCBs								
Dieldrin	2.90E-05	1.60E-02	7.12E-09	2.50E-05	2.85E-04	2.54E-09	3.20E+01	8.14E-08
Heptachlor	2.40E-05	1.10E-02	4.05E-09	3.60E-04	1.13E-05	1.45E-09	6.25E+00	9.04E-09
Semivolatile Organics								
bis(2-Ethylhexyl)phthalate	1.30E-02	3.30E-02	6.60E-06	3.80E-03	1.74E-03	2.36E-06	7.37E-02	1.74E-07
Volatile Organics								
Acetone	3.80E-03			8.30E-02				
Tetrachloroethene	1.50E-03			1.00E-02			5.20E-02	
				HAZARD INDEX =	1.99E-02		TOTAL CANCER RISK =	2.64E-07

Note:

a. Due to the volatility, volatile organics are assumed not available for dermal absorption.

Equations

CDI = (CW x SA x PC x ET x EF x ED x CF1)/(BW x AT x CF2)
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Value
CDI = Chronic Daily Intake (mg/kg-day)	Chemical-specific
CW = Concentration in Surface Water (mg/L)	Chemical-specific
SA = Skin Surface Area Available for Contact (cm^2)	9,800
PC = Chemical-specific Dermal Permeability Constant (cm/hour)	Chemical-specific
ET = Exposure Time (hours/day)	8
EF = Exposure Frequency (day/year)	5
ED = Exposure Duration (years)	25
CF1 = Volumetric Conversion Factor (0.001 L/cm^3)	0.001
BW = Body Weight (kg)	70
CF2 = Coversion Factor (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	25
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

OFF-BASE EAST SOLDIER CREEK

TABLE A-9

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
INCIDENTAL INGESTION OF CHEMICALS IN SURFACE WATER DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(CURRENT AND FUTURE USE SCENARIO)

		NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Oral RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Oral SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals									
Cadmium	1.69E-03	8.29E-05	1.40E-07	5.00E-04	2.79E-04	1.66E-05	2.79E-08		
Chromium	8.68E-03	8.29E-05	7.19E-07	3.00E-03	2.40E-04	1.66E-05	1.44E-07		
Cobalt	2.25E-04	8.29E-05	1.87E-08	6.00E-02	3.11E-07	1.66E-05	3.73E-09		
Molybdenum	2.05E-03	8.29E-05	1.70E-07	5.00E-03	3.40E-05	1.66E-05	3.40E-08		
Selenium	1.61E-03	8.29E-05	1.34E-07	5.00E-03	2.67E-05	1.66E-05	2.67E-08		
Vanadium	1.20E-02	8.29E-05	9.95E-07	7.00E-03	1.42E-04	1.66E-05	1.99E-07		
Volatile Organics									
Acetone	3.20E-03	8.29E-05	2.65E-07	1.00E-01	2.65E-06	1.66E-05	5.31E-08		
				HAZARD INDEX =	7.25E-04			TOTAL CANCER RISK =	0.00E+00

Equations

HIF = [(IRc x ETc x EFc x EDc) / BWc + (IRa x ETa x EFa x EDa) / BWa] / (CF x AT)
CDI = CW x HIF
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
HIF =	Human Intake Factor (L/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Calculated
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
IRc =	Child Ingestion Rate (L/hour)	0.025
ETc =	Child Exposure Time (hours/day)	3
EFc =	Child Exposure Frequency (days/year)	17
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
IRa =	Adult Ingestion Rate(L/hour)	0.005
ETa =	Adult Exposure Time (hour/day)	1
EFa =	Adult Exposure Frequency (days/year)	2
EDa =	Adult Exposure Duration (years)	9
BW =	Adult Body Weight (kg)	57.1
CF =	Conversion Factor (days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
Atnc =	Noncarcinogenic Averaging Time (years	14
SF =	Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-10

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
INCIDENTAL INGESTION OF CHEMICALS IN SURFACE WATER DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(CURRENT AND FUTURE USE SCENARIO)

		NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Oral RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Oral SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals									
Cadmium	2.70E-03	3.12E-04	8.41E-07	5.00E-04	1.68E-03	1.34E-04	3.61E-07		
Chromuim	1.20E-02	3.12E-04	3.74E-06	3.00E-03	1.25E-03	1.34E-04	1.60E-06		
Cobalt	2.70E-04	3.12E-04	8.41E-08	6.00E-02	1.40E-06	1.34E-04	3.61E-08		
Molybdenum	3.10E-03	3.12E-04	9.66E-07	5.00E-03	1.93E-04	1.34E-04	4.14E-07		
Selenium	3.90E-03	3.12E-04	1.22E-06	5.00E-03	2.43E-04	1.34E-04	5.21E-07		
Vanadium	1.30E-02	3.12E-04	4.05E-06	7.00E-03	5.79E-04	1.34E-04	1.74E-06		
Volatile Organics									
Acetone	3.20E-03	3.12E-04	9.97E-07	1.00E-01	9.97E-06	1.34E-04	4.27E-07		
				HAZARD INDEX =	3.96E-03			TOTAL CANCER RISK =	0.00E+00

Equations

HIF = [(IRc x ETc x EFc x EDc) / BWc + (IRa x ETa x EFa x EDa) / BWa] / (AT x CF)
CDI = CW x HIF
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
HIF =	Human Intake Factor (L/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Calculated
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
IRc =	Child Ingestion Rate (L/hour)	0.05
ETc =	Child Exposure Time (hours/day)	6
EFc =	Child Exposure Frequency (days/year)	34
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
IRa =	Adult Ingestion Rate(L/hour)	0.01
ETa =	Adult Exposure Time (hour/day)	2
EFa =	Adult Exposure Frequency (days/year)	4
EDa =	Adult Exposure Duration (years)	25
BW =	Adult Body Weight (kg)	57.1
CF =	Conversion Factor (days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	30
SF =	Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-11

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SURFACE WATER DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(CURRENT AND FUTURE USE SCENARIO)

			NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	PC[a] (cm/hr)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Dermal SF $(mg/kg-dy)^{-1}$	CANCER RISK (unitless)
Metals										
Cadmium	1.69E-03	1.00E-03	2.17E-05	3.65E-08	5.00E-06	7.30E-03	4.33E-06	7.30E-09		
Chromium	8.68E-03	1.00E-03	2.17E-05	1.88E-07	6.00E-05	3.13E-03	4.33E-06	3.76E-08		
Cobalt	2.25E-04	4.00E-04	8.66E-06	1.95E-09	4.80E-02	4.06E-08	1.73E-06	3.90E-10		
Molybdenum	2.05E-03	1.00E-03	2.17E-05	4.44E-08	1.90E-03	2.34E-05	4.33E-06	8.88E-09		
Selenium	1.61E-03	1.00E-03	2.17E-05	3.49E-08	2.20E-03	1.59E-05	4.33E-06	6.98E-09		
Vanadium	1.20E-02	1.00E-03	2.17E-05	2.60E-07	7.00E-05	3.71E-03	4.33E-06	5.20E-08		
Volatile Organics										
Acetone	3.20E-03				8.30E-02					
				HAZARD INDEX =		1.42E-02		TOTAL CANCER RISK =		0.00E+00

Note:
a. Due to the volatility, volatile organics are assumed not available for dermal absorption.

Equations

HIF ={ [(SAc x ETc x EFc x EDc) / BWc + (SAa x ETa x EFa x EDa) / BWa] / (AT x CF2)} x CF1 x PC
CDI = CW x HIF
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
HIF =	Human Intake Factor (L/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Calculated
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
PC =	Chemical-specific Dermal Permeability Constant (cm/hour)	Chemical-specific
SAc =	Child Skin Surface Area Available for Contact (cm^2)	6,500
ETc =	Child Exposure Time (hours/day)	3
EFc =	Child Exposure Frequency (days/year)	17
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
SAa =	Adult Skin Surface Area Available for Contact (cm^2)	2,800
ETa =	Adult Exposure Time (hour /day)	1
EFa =	Adult Exposure Frequency (days/year)	2
EDa =	Adult Exposure Duration (years)	9
BW =	Adult Body Weight (kg)	57.1
CF1 =	Conversion Factor (1L/1000cm^3)	0.001
CF2 =	Conversion Factor (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	14
SF =	Slope Factor ($(mg/kg-day)^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-12

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SURFACE WATER DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(CURRENT AND FUTURE USE SCENARIO)

			NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CW (mg/L)	PC (cm/hr)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (L/kg-dy)	CDI (mg/kg-dy)	Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals										
Cadmium	2.70E-03	1.00E-03	4.29E-05	1.16E-07	5.00E-06	2.31E-02	1.84E-05	4.96E-08		
Chromium	1.20E-02	1.00E-03	4.29E-05	5.14E-07	6.00E-05	8.57E-03	1.84E-05	2.20E-07		
Cobalt	2.70E-04	4.00E-04	1.71E-05	4.63E-09	4.80E-02	9.64E-08	7.35E-06	1.98E-09		
Molybdenum	3.10E-03	1.00E-03	4.29E-05	1.33E-07	1.90E-03	6.99E-05	1.84E-05	5.69E-08		
Selenium	3.90E-03	1.00E-03	4.29E-05	1.67E-07	2.20E-03	7.60E-05	1.84E-05	7.16E-08		
Vanadium	1.30E-02	1.00E-03	4.29E-05	5.57E-07	7.00E-05	7.96E-03	1.84E-05	2.39E-07		
Volatile Organics										
Acetone	3.20E-03				8.30E-02					
					HAZARD INDEX =	3.98E-02			TOTAL CANCER RISK =	0.00E+00

Note:

a. Due to the volatility, volatile organics are assumed not available for dermal absorption.

Equations

HIF ={ [(SAc x ETc x EFc x EDc) / BWc + (SAa x ETa x EFa x EDa) / BWa] / (AT x CF2)} x CF1 x PC

CDI = CW x HIF

Hazard Quotient = CDI / RfD

Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Value
HIF =	Human Intake Factor (L/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Calculated
CW =	Concentration in Surface Water (mg/L)	Chemical-specific
PC =	Chemical-specific Dermal Permeability Constant (cm/hour)	Chemical-specific
SAc =	Child Skin Surface Area Available for Contact (cm^2)	6,500
ETc =	Child Exposure Time (hours/day)	6
EFc =	Child Exposure Frequency (days/year)	34
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
SAa =	Adult Skin Surface Area Available for Contact (cm^2)	8,620
ETa =	Adult Exposure Time (hour /day)	2
EFa =	Adult Exposure Frequency (days/year)	4
EDa =	Adult Exposure Duration (years)	25
BW =	Adult Body Weight (kg)	57.1
CF1 =	Conversion Factor (1L/1000cm^3)	0.001
CF2 =	Conversion Factor (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	30
SF =	Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

OFF-BASE WEST SOLDIER CREEK

TABLE A-13

TINKER AFB SITE - OFF-BASE WEST SOLDIER CREEK
INCIDENTAL INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(CURRENT AND FUTURE USE SCENARIO)

		NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Oral RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Oral SF $(mg/kg-dy)^{-1}$	CANCER RISK (unitless)
Metals									
Arsenic	4.50E+00	1.11E-01	4.98E-07	3.00E-04	1.66E-03	2.22E-02	9.97E-08	1.50E+00	1.50E-07
Cadmium	4.39E+00	1.11E-01	4.86E-07	1.00E-03	4.86E-04	2.22E-02	9.72E-08		
Chromium	6.89E+01	1.11E-01	7.63E-06	3.00E-03	2.54E-03	2.22E-02	1.53E-06		
Thallium	1.91E+01	1.11E-01	2.11E-06	7.00E-05	3.01E-02	2.22E-02	4.22E-07		
Pesticides/PCBs									
Aroclor 1254	1.74E+00	1.11E-01	1.93E-07	2.00E-05	9.64E-03	2.22E-02	3.86E-08	2.00E+00	7.71E-08
Semivolatile Organics									
Benzidine	8.90E-02	1.11E-01	9.86E-09	3.00E-03	3.29E-06	2.22E-02	1.97E-09	2.30E+02	4.54E-07
Benzo(a)pyrene	2.26E-01	1.11E-01	2.51E-08			2.22E-02	5.01E-09	7.30E+00	3.66E-08
Dibenz(a,h)anthracene	1.80E-01	1.11E-01	1.99E-08			2.22E-02	3.99E-09	7.30E+00	2.91E-08
				HAZARD INDEX =	4.45E-02			TOTAL CANCER RISK =	7.46E-07

Equations

HIF = [(IRc x EFc x EDc) / BWc + (IRa x EFa x EDa) / BWa]/ (AT x CF2)
CDI = CS x HIF x CF1
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Values
HIF =	Human Intake Factor (mg/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Calculated
CS =	Concentration in Sediments (mg/kg)	Chemical-specific
IRc =	Child Ingestion Rate (mg/day)	100
EFc =	Child Exposure Frequency (days/year)	17
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
IRa =	Adult Ingestion Rate (mg/day)	10
EFa =	Adult Exposure Frequency (days/year)	2
EDa =	Adult Exposure Duration (years)	9
BWa =	Adult Body Weight (kg)	57.1
CF2 =	Conversion Factor 2 (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	14
CF1 =	Conversion Factor 1(0.000001 kg/mg)	0.000001
SF =	Slope Factor $((mg/kg-day)^{-1})$	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-14

TINKER AFB SITE - OFF-BASE WEST SOLDIER CREEK
INCIDENTAL INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(CURRENT AND FUTURE USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	NON-CANCER HIF (mg/kg-dy)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Oral RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER HIF (mg/kg-dy)	CANCER CDI (mg/kg-dy)	CANCER Oral SF (mg/kg-dy)-1	CANCER RISK (unitless)
Metals									
Arsenic	1.22E+01	2.22E-01	2.70E-06	3.00E-04	9.01E-03	9.50E-02	1.16E-06	1.50E+00	1.74E-06
Cadmium	1.21E+01	2.22E-01	2.68E-06	1.00E-03	2.68E-03	9.50E-02	1.15E-06		
Chromium	9.06E+01	2.22E-01	2.01E-05	3.00E-03	6.69E-03	9.50E-02	8.61E-06		
Thallium	4.31E+01	2.22E-01	9.55E-06	7.00E-05	1.36E-01	9.50E-02	4.09E-06		
Pesticides/PCBs									
Aroclor 1254	4.60E+00	2.22E-01	1.02E-06	2.00E-05	5.10E-02	9.50E-02	4.37E-07	2.00E+00	8.74E-07
Semivolatile Organics									
Benzidine	8.90E-02	2.22E-01	1.97E-08	3.00E-03	6.57E-06	9.50E-02	8.45E-09	2.30E+02	1.94E-06
Benzo(a)pyrene	5.80E-01	2.22E-01	1.29E-07			9.50E-02	5.51E-08	7.30E+00	4.02E-07
Dibenz(a,h)anthracene	1.80E-01	2.22E-01	3.99E-08			9.50E-02	1.71E-08	7.30E+00	1.25E-07
				HAZARD INDEX	2.06E-01			TOTAL CANCER RISK	5.08E-06

Equations

HIF = [(IRc x EFc x EDc) / BWc + (IRa x EFa x EDa) / BWa]/ (ATx CF2)
CDI = CS x HIF x CF1
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Values
HIF =	Human Intake Factor (mg/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Chemical-specific
CS =	Concentration in Sediments (mg/kg)	Chemical-specific
IRc =	Child Ingestion Rate (mg/day)	200
EFc =	Child Exposure Frequency (days/year)	34
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
IRa =	Adult Ingestion Rate (mg/day)	100
EFa =	Adult Exposure Frequency (days/year)	4
EDa =	Adult Exposure Duration (years)	25
BW =	Adult Body Weight (kg)	57.1
CF2 =	Conversion Factor 2 (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	30
CF1 =	Conversion Factor 1 (0.000001 kg/mg)	0.000001
SF =	Slope Factor ((mg/kg-day)$^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-15

TINKER AFB SITE - OFF-BASE WEST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(CURRENT AND FUTURE USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	ABS (unitless)	NON-CANCER HIF (mg/kg-dy)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Dermal RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER HIF (mg/kg-dy)	CANCER CDI (mg/kg-dy)	CANCER Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER CANCER RISK (unitless)
Metals										
Arsenic	4.50E+00	0.001	2.02E-03	9.08E-09	1.23E-04	7.38E-05	4.03E-04	1.82E-09	3.66E+00	6.64E-09
Cadmium	4.39E+00	0.001	2.02E-03	8.85E-09	1.00E-05	8.85E-04	4.03E-04	1.77E-09		
Chromium	6.89E+01	0.001	2.02E-03	1.39E-07	6.00E-05	2.32E-03	4.03E-04	2.78E-08		
Thallium	1.91E+01	0.001	2.02E-03	3.84E-08	1.05E-05	3.66E-03	4.03E-04	7.69E-09		
Pesticides/PCBs										
Aroclor 1254	1.74E+00	0.01	2.02E-02	3.51E-08	1.80E-05	1.95E-03	4.03E-03	7.02E-09	2.20E+00	1.54E-08
Semivolatile Organics										
Benzidine	8.90E-02	0.01	2.02E-02	1.80E-09	2.40E-03	7.48E-07	4.03E-03	3.59E-10	2.88E+02	1.03E-07
Benzo(a)pyrene	2.26E-01	0.01	2.02E-02	4.56E-09			4.03E-03	9.13E-10	2.35E+01	2.15E-08
Dibenz(a,h)anthracene	1.80E-01	0.01	2.02E-02	3.63E-09			4.03E-03	7.26E-10	2.35E+01	1.71E-08
					HAZARD INDEX =	8.89E-03			TOTAL CANCER RISK =	1.64E-07

Equations

HIF = {[(SAc x EFc x EDc x ABS) / BWc + (SAa x EFa x EDa x ABS) / BWa] x AF} / (AT x CF2)
CDI = CS x HIF x CF1
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Values
HIF =	Human Intake Factor (mg/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Chemical-specific
CS =	Concentration in Sediments (mg/kg)	Chemical-specific
SAc =	Child Skin Surface Area Available for Contact (cm^2)	1,800
EFc =	Child Exposure Frequency (days/year)	17
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
SAa =	Adult Skin Surface Area Available for Contact (cm^2)	2,800
EFa =	Adult Exposure Frequency (days/year)	2
EDa =	Adult Exposure Duration (years)	9
BW =	Adult Body Weight (kg)	57.1
AF =	Adherence Factor (mg/cm^2-day)	0.2
ABS =	Absorption Factor (unitless)	Chemical-type specific
CF2 =	Conversion Factor 2 (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	14
CF1 =	Conversion Factor 1 (0.000001 kg/mg)	1.00E-06
SF =	Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-16

TINKER AFB SITE - OFF-BASE WEST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(CURRENT AND FUTURE USE SCENARIO)

			NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	**CS (mg/kg)**	**ABS (unitless)**	**HIF (mg/kg-dy)**	**CDI (mg/kg-dy)**	**Dermal RfD (mg/kg-dy)**	**HAZARD QUOTIENT (unitless)**	**HIF (mg/kg-dy)**	**CDI (mg/kg-dy)**	**Dermal SF $(mg/kg\text{-}dy)^{-1}$**	**CANCER RISK (unitless)**
Metals										
Arsenic	1.22E+01	0.001	8.06E-03	9.84E-08	1.23E-04	8.00E-04	3.45E-03	4.22E-08	3.66E+00	1.54E-07
Cadmium	1.21E+01	0.001	8.06E-03	9.75E-08	1.00E-05	9.75E-03	3.45E-03	4.18E-08		
Chromium	9.06E+01	0.001	8.06E-03	7.30E-07	6.00E-05	1.22E-02	3.45E-03	3.13E-07		
Thallium	4.31E+01	0.001	8.06E-03	3.47E-07	1.05E-05	3.31E-02	3.45E-03	1.49E-07		
Pesticides/PCBs										
Aroclor 1254	4.60E+00	0.01	8.06E-02	3.71E-07	1.80E-05	2.06E-02	3.45E-02	1.59E-07	2.20E+00	3.50E-07
Semivolatile Organics										
Benzidine	8.90E-02	0.01	8.06E-02	7.17E-09	2.40E-03	2.99E-06	3.45E-02	3.07E-09	2.88E+02	8.84E-07
Benzo(a)pyrene	5.80E-01	0.01	8.06E-02	4.68E-08			3.45E-02	2.00E-08	2.35E+01	4.72E-07
Dibenz(a,h)anthracene	1.80E-01	0.01	8.06E-02	1.45E-08			3.45E-02	6.22E-09	2.35E+01	1.46E-07
					HAZARD INDEX =	7.64E-02			TOTAL CANCER RISK =	2.01E-06

Equations

HIF = {[(SAc x EFc x EDc x ABS) / BWc + (SAa x EFa x EDa x ABS) / BWa] x AF} / (AT x CF2)
CDI = CS x CF1 x HIF
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Values
HIF =	Human Intake Factor (mg/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Chemical-specific
CS =	Concentration in Sediments (mg/kg)	Chemical-specific
SAc =	Child Skin Surface Area Available for Contact (cm^2)	6,500
EFc =	Child Exposure Frequency (days/year)	34
EDc =	Child Exposure Duration (years)	5
BWc =	Child Body Weight (kg)	15.1
SAa =	Adult Skin Surface Area Available for Contact (cm^2)	8,620
EFa =	Adult Exposure Frequency (days/year)	4
EDa =	Adult Exposure Duration (years)	25
BW =	Adult Body Weight (kg)	57.1
AF =	Adherence Factor (mg/cm^2-day)	1
ABS =	Absorption Factor (unitless)	Chemical-type specific
CF2 =	Conversion Factor 2 (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	30
CF1 =	Conversion Factor 1 (0.000001 kg/mg)	1.00E-06
SF =	Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

ON-BASE EAST SOLDIER CREEK

TABLE A-17

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT ON-BASE CONSTRUCTION WORKER - AVERAGE EXPOSURE (CURRENT USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Oral RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER CDI (mg/kg-dy)	CANCER Oral SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals							
Arsenic	3.41E+00	1.34E-09	3.00E-04	4.45E-06	9.54E-11	1.50E+00	1.43E-10
Cadmium	3.12E+01	1.22E-08	1.00E-03	1.22E-05	8.72E-10		
Chromium	2.48E+02	9.69E-08	3.00E-03	3.23E-05	6.92E-09		
Copper	2.57E+02	1.00E-07	4.00E-02	2.51E-06	7.18E-09		
Lead	1.55E+02	6.08E-08	NTF[a]		4.34E-09		
Manganese	6.67E+02	2.61E-07	2.00E-02	1.30E-05	1.86E-08		
Mercury[b]	3.16E-01	1.24E-10	1.00E-04	1.24E-06	8.82E-12		
Molybdenum	1.20E+01	4.69E-09	5.00E-03	9.39E-07	3.35E-10		
Nickel	2.82E+02	1.10E-07	2.00E-02	5.52E-06	7.88E-09		
Silver	3.06E+00	1.20E-09	5.00E-03	2.39E-07	8.55E-11		
Thallium	3.18E+01	1.25E-08	7.00E-05	1.78E-04	8.90E-10		
Vanadium	2.77E+01	1.09E-08	7.00E-03	1.55E-06	7.75E-10		
Pesticides/PCBs							
Aldrin	2.68E-02	1.05E-11	3.00E-05	3.50E-07	7.49E-13	1.70E+01	1.27E-11
Aroclor 1254	1.77E+00	6.94E-10	2.00E-05	3.47E-05	4.96E-11	2.00E+00	9.91E-11
Semivolatile Organics							
Benzo(a)anthracene	1.82E+00	7.14E-10			5.10E-11	7.30E-01	3.72E-11
Benzo(a)pyrene	1.99E+00	7.81E-10			5.58E-11	7.30E+00	4.07E-10
Benzo(b)fluoranthene	2.14E+00	8.37E-10			5.98E-11	7.30E-01	4.37E-11
Benzo(k)fluoranthene	1.73E+00	6.79E-10			4.85E-11	7.30E-02	3.54E-12
Dibenz(a,h)anthracene	6.58E-01	2.58E-10			1.84E-11	7.30E+00	1.34E-10
Indeno(1,2,3-cd)pyrene	1.64E+00	6.41E-10			4.58E-11	7.30E-01	3.34E-11
			HAZARD INDEX =	2.87E-04	TOTAL CANCER RISK =		9.14E-10

Notes:

a. NTF = No critical toxicity values. surrogate toxicity values are not available for these chemicals; therefore, they were not evaluated in the quantitative risk assessment.

b. RfD for methylmercury.

Equations

CDI = (CS x CF1 x IR x EF x ED)/(BW x AT x CF2)

Hazard Quotient = CDI / RfD

Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
CDI = Chronic Daily Intake (mg/kg-day)	Calculated
CS = Concentration in Sediments (mg/kg)	Chemical-specific
CF1 = Conversion Factor 1 (10^{-6} kg/mg)	1.00E-06
IR = Sediment Ingestion Rate (mg/day)	10
EF = Exposure Frequency (day/year)	1
ED = Exposure Duration (years)	5
BW = Body Weight (kg)	70
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	5
SF = Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-18

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT
ON-BASE CONSTRUCTION WORKER - RME
(CURRENT USE SCENARIO)

		NON-CANCER			CANCER		
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	CDI (mg/kg-dy)	Oral RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	CDI (mg/kg-dy)	Oral SF (mg/kg-dy)-1	CANCER RISK (unitless)
Metals							
Arsenic	6.29E+00	6.16E-08	3.00E-04	2.05E-04	2.20E-08	1.50E+00	3.30E-08
Cadmium	2.79E+02	2.73E-06	1.00E-03	2.73E-03	9.76E-07		
Chromium	7.32E+02	7.16E-06	3.00E-03	2.39E-03	2.56E-06		
Copper	1.39E+03	1.36E-05	4.00E-02	3.40E-04	4.86E-06		
Lead	4.14E+02	4.05E-06	NTFa		1.45E-06		
Manganese	1.11E+03	1.09E-05	2.00E-02	5.43E-04	3.88E-06		
Mercury[b]	1.20E+00	1.17E-08	1.00E-04	1.17E-04	4.19E-09		
Molybdenum	4.88E+01	4.78E-07	5.00E-03	9.56E-05	1.71E-07		
Nickel	8.71E+02	8.52E-06	2.00E-02	4.26E-04	3.04E-06		
Silver	6.58E+00	6.44E-08	5.00E-03	1.29E-05	2.30E-08		
Thallium	6.18E+01	6.05E-07	7.00E-05	8.64E-03	2.16E-07		
Vanadium	4.16E+01	4.07E-07	7.00E-03	5.82E-05	1.45E-07		
Pesticides/PCBs							
Aldrin	1.10E-01	1.08E-09	3.00E-05	3.59E-05	3.84E-10	1.70E+01	6.53E-09
Aroclor 1254	1.30E+01	1.27E-07	2.00E-05	6.36E-03	4.54E-08	2.00E+00	9.09E-08
Semivolatile Organics							
Benzo(a)anthracene	8.00E+00	7.83E-08			2.80E-08	7.30E-01	2.04E-08
Benzo(a)pyrene	8.65E+00	8.46E-08			3.02E-08	7.30E+00	2.21E-07
Benzo(b)fluoranthene	9.41E+00	9.20E-08			3.29E-08	7.30E-01	2.40E-08
Benzo(k)fluoranthene	6.93E+00	6.78E-08			2.42E-08	7.30E-02	1.77E-09
Dibenz(a,h)anthracene	1.23E+00	1.20E-08			4.29E-09	7.30E+00	3.13E-08
Indeno(1,2,3-cd)pyrene	7.10E+00	6.94E-08			2.48E-08	7.30E-01	1.81E-08
			HAZARD INDEX =	2.20E-02		TOTAL CANCER RISK =	4.47E-07

Notes:

a. NTF = No critical toxicity values, surrogate toxicity values are not available for these chemicals; therefore, they were not evaluated in the quantitative risk assessment.

b. RfD for methylmercury.

Equations

CDI = (CS x CF1 x IR x EF x ED)/(BW x AT x CF2)
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
CDI = Chronic Daily Intake (mg/kg-day)	Calculated
CS = Concentration in Sediments (mg/kg)	Chemical-specific
CF1 = Conversion Factor 1 (10^{-6} kg/mg)	1.00E-06
IR = Sediment Ingestion Rate (mg/day)	50
EF = Exposure Frequency (day/year)	5
ED = Exposure Duration (years)	25
BW = Body Weight (kg)	70
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	25
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-19

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT
ON-BASE CONSTRUCTION WORKER - AVERAGE EXPOSURE
(CURRENT USE SCENARIO)

			NON-CANCER			CANCER		
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	ABS (unitless)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	CDI (mg/kg-dy)	Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals								
Arsenic	3.41E+00	0.001	5.34E-11	1.23E-04	4.34E-07	3.82E-12	3.66E+00	1.40E-11
Cadmium	3.12E+01	0.001	4.88E-10	1.00E-05	4.88E-05	3.49E-11		
Chromium	2.48E+02	0.001	3.87E-09	6.00E-05	6.46E-05	2.77E-10		
Copper	2.57E+02	0.001	4.02E-09	1.20E-02	3.35E-07	2.87E-10		
Lead	1.55E+02	0.001	2.43E-09	NTFa		1.74E-10		
Manganese	6.67E+02	0.001	1.04E-08	8.00E-04	1.30E-05	7.46E-10		
Mercury[b]	3.16E-01	0.001	4.94E-12	9.00E-05	5.49E-08	3.53E-13		
Molybdenum	1.20E+01	0.001	1.88E-10	1.90E-03	9.88E-08	1.34E-11		
Nickel	2.82E+02	0.001	4.42E-09	5.40E-03	8.18E-07	3.15E-10		
Silver	3.06E+00	0.001	4.79E-11	9.00E-04	5.32E-08	3.42E-12		
Thallium	3.18E+01	0.001	4.98E-10	1.05E-05	4.75E-05	3.56E-11		
Vanadium	2.77E+01	0.001	4.34E-10	7.00E-05	6.20E-06	3.10E-11		
Pesticides/PCBs								
Aldrin	2.68E-02	0.01	4.20E-12	1.50E-05	2.80E-07	3.00E-13	3.40E+01	1.02E-11
Aroclor 1254	1.77E+00	0.01	2.78E-10	1.80E-05	1.54E-05	1.98E-11	2.22E+00	4.41E-11
Semivolatile Organics								
Benzo(a)anthracene	1.82E+00	0.01	2.85E-10			2.04E-11	2.35E+00	4.80E-11
Benzo(a)pyrene	1.99E+00	0.01	3.12E-10			2.23E-11	2.35E+01	5.25E-10
Benzo(b)fluoranthene	2.14E+00	0.01	3.35E-10			2.39E-11	2.35E+00	5.63E-11
Benzo(k)fluoranthene	1.73E+00	0.01	2.72E-10			1.94E-11	2.35E-01	4.57E-12
Dibenz(a,h)anthracene	6.58E-01	0.01	1.03E-10			7.36E-12	2.35E+01	1.73E-10
Indeno(1,2,3-cd)pyrene	1.64E+00	0.01	2.57E-10			1.83E-11	2.35E+00	4.31E-11
				HAZARD INDEX =	1.98E-04		TOTAL CANCER RISK	9.19E-10

Notes:

a. NTF = No critical toxicity values. surrogate toxicity values are not available for these chemicals; therefore, they were not evaluated in the quantitative risk assessment.

b. RfD for methylmercury.

Equations

CDI = (CS x CF1 x SA x AF x ABS x EF x ED)/(BW x AT x CF2)
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
CDI = Chronic Daily Intake (mg/kg-day)	Calculated
CS = Concentration in Sediments (mg/kg)	Chemical-specific
CF1 = Conversion Factor 1 (10^{-6} kg/mg)	1.00E-06
SA = Skin Surface Area Available for Contact (cm^2)	2,000
AF = Adherence Factor (mg/cm^2-day)	0.2
ABS = Absorption Factor (unitless)	Chemical-type specific
EF = Exposure Frequency (days/year)	1
ED = Exposure Duration (years)	5
BW = Body Weight (kg)	70
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	5
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-20

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT
ON-BASE CONSTRUCTION WORKER - RME
(CURRENT USE SCENARIO)

			NON-CANCER			CANCER		
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	ABS (unitless)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	CDI (mg/kg-dy)	Dermal SF (mg/kg-dy)-1	CANCER RISK (unitless)
Metals								
Arsenic	6.29E+00	0.001	1.21E-08	1.23E-04	9.81E-05	4.31E-09	3.66E+00	1.58E-08
Cadmium	2.79E+02	0.001	5.36E-07	1.00E-05	5.36E-02	1.91E-07		
Chromium	7.32E+02	0.001	1.40E-06	6.00E-05	2.34E-02	5.01E-07		
Copper	1.39E+03	0.001	2.67E-06	1.20E-02	2.22E-04	9.52E-07		
Lead	4.14E+02	0.001	7.94E-07	NTFa		2.84E-07		
Manganese	1.11E+03	0.001	2.13E-06	8.00E-04	2.66E-03	7.60E-07		
Mercury[b]	1.20E+00	0.001	2.30E-09	9.00E-05	2.56E-05	8.22E-10		
Molybdenum	4.88E+01	0.001	9.37E-08	1.90E-03	4.93E-05	3.35E-08		
Nickel	8.71E+02	0.001	1.67E-06	5.40E-03	3.09E-04	5.96E-07		
Silver	6.58E+00	0.001	1.26E-08	9.00E-04	1.40E-05	4.51E-09		
Thallium	6.18E+01	0.001	1.19E-07	1.05E-05	1.13E-02	4.23E-08		
Vanadium	4.16E+01	0.001	7.98E-08	7.00E-05	1.14E-03	2.85E-08		
Pesticides/PCBs								
Aldrin	1.10E-01	0.01	2.11E-09	1.50E-05	1.41E-04	7.53E-10	3.40E+01	2.56E-08
Aroclor 1254	1.30E+01	0.01	2.49E-07	1.80E-05	1.39E-02	8.90E-08	2.22E+00	1.98E-07
Semivolatile Organics								
Benzo(a)anthracene	8.00E+00	0.01	1.53E-07			5.48E-08	2.35E+00	1.29E-07
Benzo(a)pyrene	8.65E+00	0.01	1.66E-07			5.93E-08	2.35E+01	1.40E-06
Benzo(b)fluoranthene	9.41E+00	0.01	1.80E-07			6.44E-08	2.35E+00	1.52E-07
Benzo(k)fluoranthene	6.93E+00	0.01	1.33E-07			4.74E-08	2.35E-01	1.12E-08
Dibenz(a,h)anthracene	1.23E+00	0.01	2.35E-08			8.40E-09	2.35E+01	1.98E-07
Indeno(1,2,3-cd)pyrene	7.10E+00	0.01	1.36E-07			4.86E-08	2.35E+00	1.14E-07
			HAZARD INDEX =		1.07E-01	TOTAL CANCER RISK =		2.24E-06

Notes:

a. NTF = No critical toxicity values. surrogate toxicity values are not available for these chemicals; therefore, they were not evaluated in the quantitative risk assessment.

b. RfD for methylmercury.

Equations

CDI = (CS x CF1 x SA x AF x ABS x EF x ED)/(BW x AT x CF2)
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
CDI = Chronic Daily Intake (mg/kg-day)	Calculated
CS = Concentration in Sediments (mg/kg)	Chemical-specific
CF1 = Conversion Factor 1 (10^{-6} kg/mg)	1.00E-06
SA = Skin Surface Area Available for Contact (cm^2)	9,800
AF = Adherence Factor (mg/cm^2-day)	1
ABS = Absorption Factor (unitless)	Chemical-type specific
EF = Exposure Frequency (days/year)	5
ED = Exposure Duration (years)	25
BW = Body Weight (kg)	70
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	25
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-21

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT
ON-BASE CONSTRUCTION WORKER - AVERAGE EXPOSURE
(FUTURE USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Oral RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER CDI (mg/kg-dy)	CANCER Oral SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals							
Antimony	4.01E+00	1.57E-09	4.00E-04	3.92E-06	1.12E-10		
Arsenic	2.98E+00	1.16E-09	3.00E-04	3.88E-06	8.32E-11	1.50E+00	1.25E-10
Cadmium	3.56E+01	1.39E-08	1.00E-03	1.39E-05	9.94E-10		
Chromium	3.02E+02	1.18E-07	3.00E-03	3.94E-05	8.44E-09		
Copper	1.74E+02	6.81E-08	4.00E-02	1.70E-06	4.86E-09		
Lead	1.34E+02	5.23E-08	NTFa		3.74E-09		
Manganese	5.71E+02	2.24E-07	2.00E-02	1.12E-05	1.60E-08		
Mercury[b]	3.49E-01	1.36E-10	1.00E-04	1.36E-06	9.74E-12		
Molybdenum	9.08E+00	3.55E-09	5.00E-03	7.11E-07	2.54E-10		
Nickel	1.88E+02	7.37E-08	2.00E-02	3.68E-06	5.26E-09		
Silver	6.13E+00	2.40E-09	5.00E-03	4.80E-07	1.71E-10		
Thallium	4.40E+01	1.72E-08	7.00E-05	2.46E-04	1.23E-09		
Vanadium	2.40E+01	9.39E-09	7.00E-03	1.34E-06	6.70E-10		
Pesticides/PCBs							
Aldrin	8.92E-02	3.49E-11	3.00E-05	1.16E-06	2.49E-12	1.70E+01	4.24E-11
Aroclor 1254	2.59E+00	1.01E-09	2.00E-05	5.07E-05	7.25E-11	2.00E+00	1.45E-10
Semivolatile Organics							
Benzidine	9.40E-02	3.68E-11	3.00E-03	1.23E-08	2.63E-12	2.30E+02	6.04E-10
Benzo(a)anthracene	4.10E+00	1.61E-09			1.15E-10	7.30E-01	8.37E-11
Benzo(a)pyrene	4.82E+00	1.89E-09			1.35E-10	7.30E+00	9.85E-10
Benzo(b)fluoranthene	4.66E+00	1.82E-09			1.30E-10	7.30E-01	9.51E-11
Benzo(k)fluoranthene	4.28E+00	1.67E-09			1.20E-10	7.30E-02	8.73E-12
Dibenz(a,h)anthracene	1.34E+00	5.26E-10			3.76E-11	7.30E+00	2.74E-10
Indeno(1,2,3-cd)pyrene	3.81E+00	1.49E-09			1.06E-10	7.30E-01	7.77E-11
			HAZARD INDEX =	3.79E-04		TOTAL CANCER RISK =	2.44E-09

Notes:

a. NTF = No critical toxicity values, surrogate toxicity values are not available for these chemicals; therefore, they were not evaluated in the quantitative risk assessment.

b. RfD for methylmercury.

Equations

CDI = (CS x CF1 x IR x EF x ED)/(BW x AT x CF2)

Hazard Quotient = CDI / RfD

Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
CDI = Chronic Daily Intake (mg/kg-day)	Calculated
CS = Concentration in Sediments (mg/kg)	Chemical-specific
CF1 = Conversion Factor 1 (10^{-6} kg/mg)	1.00E-06
IR = Sediment Ingestion Rate (mg/day)	10
EF = Exposure Frequency (day/year)	1
ED = Exposure Duration (years)	5
BW = Body Weight (kg)	70
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	5
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-22

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT
ON-BASE CONSTRUCTION WORKER - RME
(FUTURE USE SCENARIO)

		NON-CANCER			CANCER		
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	CDI (mg/kg-dy)	Oral RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	CDI (mg/kg-dy)	Oral SF (mg/kg-dy)-1	CANCER RISK (unitless)
Metals							
Antimony	4.61E+00	4.51E-08	4.00E-04	1.13E-04	1.61E-08		
Arsenic	3.97E+00	3.89E-08	3.00E-04	1.30E-04	1.39E-08	1.50E+00	2.08E-08
Cadmium	1.49E+02	1.46E-06	1.00E-03	1.46E-03	5.22E-07		
Chromium	6.19E+02	6.05E-06	3.00E-03	2.02E-03	2.16E-06		
Copper	4.21E+02	4.12E-06	4.00E-02	1.03E-04	1.47E-06		
Lead	2.31E+02	2.26E-06	NTFa		8.07E-07		
Manganese	7.12E+02	6.97E-06	2.00E-02	3.48E-04	2.49E-06		
Mercury[b]	8.27E-01	8.10E-09	1.00E-04	8.10E-05	2.89E-09		
Molybdenum	1.64E+01	1.61E-07	5.00E-03	3.21E-05	5.73E-08		
Nickel	2.67E+02	2.62E-06	2.00E-02	1.31E-04	9.35E-07		
Silver	9.89E+00	9.67E-08	5.00E-03	1.93E-05	3.45E-08		
Thallium	6.18E+01	6.05E-07	7.00E-05	8.64E-03	2.16E-07		
Vanadium	2.98E+01	2.91E-07	7.00E-03	4.16E-05	1.04E-07		
Pesticides/PCBs							
Aldrin	1.10E-01	1.08E-09	3.00E-05	3.59E-05	3.84E-10	1.70E+01	6.53E-09
Aroclor 1254	1.30E+01	1.27E-07	2.00E-05	6.36E-03	4.54E-08	2.00E+00	9.09E-08
Semivolatile Organics							
Benzidine	9.40E-02	9.20E-10	3.00E-03	3.07E-07	3.28E-10	2.30E+02	7.56E-08
Benzo(a)anthracene	9.39E+00	9.19E-08			3.28E-08	7.30E-01	2.40E-08
Benzo(a)pyrene	1.12E+01	1.09E-07			3.91E-08	7.30E+00	2.85E-07
Benzo(b)fluoranthene	1.00E+01	9.81E-08			3.51E-08	7.30E-01	2.56E-08
Benzo(k)fluoranthene	8.38E+00	8.20E-08			2.93E-08	7.30E-02	2.14E-09
Dibenz(a,h)anthracene	1.77E+00	1.73E-08			6.18E-09	7.30E+00	4.51E-08
Indeno(1,2,3-cd)pyrene	7.74E+00	7.58E-08			2.71E-08	7.30E-01	1.98E-08
			HAZARD INDEX =	1.95E-02		TOTAL CANCER RISK =	5.96E-07

Notes:

a. NTF = No critical toxicity values, surrogate toxicity values are not available for these chemicals; therefore, they were not evaluated in the quantitative risk assessment.

b. RfD for methylmercury.

Equations

CDI = (CS x CF1 x IR x EF x ED)/(BW x AT x CF2)

Hazard Quotient = CDI / RfD

Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
CDI = Chronic Daily Intake (mg/kg-day)	Calculated
CS = Concentration in Sediments (mg/kg)	Chemical-specific
CF1 = Conversion Factor 1 (10^{-6} kg/mg)	1.00E-06
IR = Sediment Ingestion Rate (mg/day)	50
EF = Exposure Frequency (day/year)	5
ED = Exposure Duration (years)	25
BW = Body Weight (kg)	70
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	25
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-23

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT
ON-BASE CONSTRUCTION WORKER - AVERAGE EXPOSURE
(FUTURE USE SCENARIO)

			NON-CANCER			CANCER		
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	ABS (unitless)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	CDI (mg/kg-dy)	Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals								
Antimony	4.01E+00	0.001	6.28E-11	8.00E-06	7.85E-06	4.48E-12		
Arsenic	2.98E+00	0.001	4.66E-11	1.23E-04	3.79E-07	3.33E-12	3.66E+00	1.22E-11
Cadmium	3.56E+01	0.001	5.57E-10	1.00E-05	5.57E-05	3.98E-11		
Chromium	3.02E+02	0.001	4.73E-09	6.00E-05	7.88E-05	3.38E-10		
Copper	1.74E+02	0.001	2.72E-09	1.20E-02	2.27E-07	1.95E-10		
Lead	1.34E+02	0.001	2.09E-09	NTFa		1.50E-10		
Manganese	5.71E+02	0.001	8.94E-09	8.00E-04	1.12E-05	6.39E-10		
Mercury[b]	3.49E-01	0.001	5.46E-12	9.00E-05	6.06E-08	3.90E-13		
Molybdenum	9.08E+00	0.001	1.42E-10	1.90E-03	7.48E-08	1.02E-11		
Nickel	1.88E+02	0.001	2.95E-09	5.40E-03	5.46E-07	2.11E-10		
Silver	6.13E+00	0.001	9.60E-11	9.00E-04	1.07E-07	6.86E-12		
Thallium	4.40E+01	0.001	6.88E-10	1.05E-05	6.55E-05	4.91E-11		
Vanadium	2.40E+01	0.001	3.75E-10	7.00E-05	5.36E-06	2.68E-11		
Pesticides/PCBs								
Aldrin	8.92E-02	0.01	1.40E-11	1.50E-05	9.31E-07	9.97E-13	3.40E+01	3.39E-11
Aroclor 1254	2.59E+00	0.01	4.06E-10	1.80E-05	2.25E-05	2.90E-11	2.22E+00	6.44E-11
Semivolatile Organics								
Benzidine	9.40E-02	0.01	1.47E-11	2.40E-03	6.13E-09	1.05E-12	2.88E+02	3.03E-10
Benzo(a)anthracene	4.10E+00	0.01	6.42E-10			4.59E-11	2.35E+00	1.08E-10
Benzo(a)pyrene	4.82E+00	0.01	7.55E-10			5.39E-11	2.35E+01	1.27E-09
Benzo(b)fluoranthene	4.66E+00	0.01	7.30E-10			5.21E-11	2.35E+00	1.23E-10
Benzo(k)fluoranthene	4.28E+00	0.01	6.69E-10			4.78E-11	2.35E-01	1.13E-11
Dibenz(a,h)anthracene	1.34E+00	0.01	2.10E-10			1.50E-11	2.35E+01	3.54E-10
Indeno(1,2,3-cd)pyrene	3.81E+00	0.01	5.96E-10			4.26E-11	2.35E+00	1.00E-10
			HAZARD INDEX =		2.49E-04	TOTAL CANCER RISK =		2.38E-09

Notes:

a. NTF = No critical toxicity values. surrogate toxicity values are not available for these chemicals; therefore, they were not evaluated in the quantitative risk assessment.

b. RfD for methylmercury.

Equations

CDI = (CS x CF1 x SA x AF x ABS x EF x ED)/(BW x AT x CF2)
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
CDI = Chronic Daily Intake (mg/kg-day)	Calculated
CS = Concentration in Sediments (mg/kg)	Chemical-specific
CF1 = Conversion Factor 1 (10^{-6} kg/mg)	1.00E-06
SA = Skin Surface Area Available for Contact (cm^2)	2,000
AF = Adherence Factor (mg/cm^2-day)	0.2
ABS = Absorption Factor (unitless)	Chemical-type specific
EF = Exposure Frequency (days/year)	1
ED = Exposure Duration (years)	5
BW = Body Weight (kg)	70
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	5
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-24

TINKER AFB SITE - ON-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT
ON-BASE CONSTRUCTION WORKER - RME
(FUTURE USE SCENARIO)

			NON-CANCER			CANCER		
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	ABS (unitless)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	CDI (mg/kg-dy)	Dermal SF (mg/kg-dy)-1	CANCER RISK (unitless)
Metals								
Antimony	4.61E+00	0.001	8.84E-09	8.00E-06	1.10E-03	3.16E-09		
Arsenic	3.97E+00	0.001	7.62E-09	1.23E-04	6.19E-05	2.72E-09	3.66E+00	9.95E-09
Cadmium	1.49E+02	0.001	2.86E-07	1.00E-05	2.86E-02	1.02E-07		
Chromium	6.19E+02	0.001	1.19E-06	6.00E-05	1.98E-02	4.24E-07		
Copper	4.21E+02	0.001	8.07E-07	1.20E-02	6.72E-05	2.88E-07		
Lead	2.31E+02	0.001	4.43E-07	NTFa		1.58E-07		
Manganese	7.12E+02	0.001	1.37E-06	8.00E-04	1.71E-03	4.88E-07		
Mercury[b]	8.27E-01	0.001	1.59E-09	9.00E-05	1.76E-05	5.67E-10		
Molybdenum	1.64E+01	0.001	3.15E-08	1.90E-03	1.66E-05	1.12E-08		
Nickel	2.67E+02	0.001	5.13E-07	5.40E-03	9.50E-05	1.83E-07		
Silver	9.89E+00	0.001	1.90E-08	9.00E-04	2.11E-05	6.77E-09		
Thallium	6.18E+01	0.001	1.19E-07	1.05E-05	1.13E-02	4.23E-08		
Vanadium	2.98E+01	0.001	5.71E-08	7.00E-05	8.16E-04	2.04E-08		
Pesticides/PCBs								
Aldrin	1.10E-01	0.01	2.11E-09	1.50E-05	1.41E-04	7.53E-10	3.40E+01	2.56E-08
Aroclor 1254	1.30E+01	0.01	2.49E-07	1.80E-05	1.39E-02	8.90E-08	2.22E+00	1.98E-07
Semivolatile Organics								
Benzidine	9.40E-02	0.01	1.80E-09	2.40E-03	7.51E-07	6.44E-10	2.88E+02	1.85E-07
Benzo(a)anthracene	9.39E+00	0.01	1.80E-07			6.43E-08	2.35E+00	1.51E-07
Benzo(a)pyrene	1.12E+01	0.01	2.15E-07			7.66E-08	2.35E+01	1.80E-06
Benzo(b)fluoranthene	1.00E+01	0.01	1.92E-07			6.87E-08	2.35E+00	1.62E-07
Benzo(k)fluoranthene	8.38E+00	0.01	1.61E-07			5.74E-08	2.35E-01	1.35E-08
Dibenz(a,h)anthracene	1.77E+00	0.01	3.39E-08			1.21E-08	2.35E+01	2.85E-07
Indeno(1,2,3-cd)pyrene	7.74E+00	0.01	1.49E-07			5.30E-08	2.35E+00	1.25E-07
				HAZARD INDEX =	7.76E-02		TOTAL CANCER RISK =	2.96E-06

Notes:

a. NTF No critical toxicity values. surrogate toxicity values are not available for these chemicals; therefore, they were not evaluated in the quantitative risk assessment.

b. RfD for methylmercury.

Equations

CDI = (CS x CF1 x SA x AF x ABS x EF x ED)/(BW x AT x CF2)

Hazard Quotient = CDI / RfD

Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
CDI = Chronic Daily Intake (mg/kg-day)	Calculated
CS = Concentration in Sediments (mg/kg)	Chemical-specific
CF1 = Conversion Factor 1 (10^{-6} kg/mg)	1.00E-06
SA = Skin Surface Area Available for Contact (cm^2)	9,800
AF = Adherence Factor (mg/cm^2-day)	1
ABS = Absorption Factor (unitless)	Chemical-type specific
EF = Exposure Frequency (days/year)	5
ED = Exposure Duration (years)	25
BW = Body Weight (kg)	70
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	25
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

OFF-BASE EAST SOLDIER CREEK

TABLE A-25

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
INCIDENTAL INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(CURRENT USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	NON-CANCER HIF (mg/kg-dy)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Oral RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER HIF (mg/kg-dy)	CANCER CDI (mg/kg-dy)	CANCER Oral SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals									
Barium	1.48E+03	1.11E-01	1.64E-04	7.00E-02	2.35E-03	2.22E-02	3.29E-05		
Cadmium	2.02E+01	1.11E-01	2.23E-06	1.00E-03	2.23E-03	2.22E-02	4.46E-07		
Chromium	1.34E+02	1.11E-01	1.48E-05	3.00E-03	4.93E-03	2.22E-02	2.96E-06		
Semivolatile Organics									
Benzo(a)pyrene	8.20E-02	1.11E-01	9.08E-09			2.22E-02	1.82E-09	7.30E+00	1.33E-08
				HAZARD INDEX =	9.51E-03			TOTAL CANCER RISK =	1.33E-08

Equations

HIF = [(IRc x EFc x EDc) / BWc + (IRa x EFa x EDa) / BWa]/ (ATx CF2)
CDI = CS x HIF x CF1
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
HIF= Human Intake Factor (mg/kg-day)	Calculated
CDI= Chronic Daily Intake (mg/kg-day)	Calculated
CS= Concentration in Sediments (mg/kg)	Chemical-specific
IRc= Child Ingestion Rate (mg/day)	100
EFc= Child Exposure Frequency (days/year)	17
EDc= Child Exposure Duration (years)	5
BWc= Child Body Weight (kg)	15.1
IRa= Adult Ingestion Rate (mg/day)	10
EFa= Adult Exposure Frequency (days/year)	2
EDa= Adult Exposure Duration (years)	9
BWa= Adult Body Weight (kg)	57.1
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	14
CF1 = Conversion Factor 1(0.000001 kg/mg)	0.000001
SF = Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-26

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
INCIDENTAL INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(CURRENT USE SCENARIO)

		NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Oral RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Oral SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals									
Barium	4.55E+03	2.22E-01	1.01E-03	7.00E-02	1.44E-02	9.50E-02	4.32E-04		
Cadmium	5.20E+01	2.22E-01	1.15E-05	1.00E-03	1.15E-02	9.50E-02	4.94E-06		
Chromium	2.69E+02	2.22E-01	5.96E-05	3.00E-03	1.99E-02	9.50E-02	2.56E-05		
Semivolatile Organics									
Benzo(a)pyrene	8.20E-02	2.22E-01	1.82E-08			9.50E-02	7.79E-09	7.30E+00	5.69E-08
				HAZARD INDEX =	4.58E-02			TOTAL CANCER RISK =	5.69E-08

Equations

HIF = [(IRc x EFc x EDc) / BWc + (IRa x EFa x EDa) / BWa]/ (ATx CF2)
CDI = CS x HIF x CF1
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Values
HIF=	Human Intake Factor (mg/kg-day)	Calculated
CDI=	Chronic Daily Intake (mg/kg-day)	Calculated
CS=	Concentration in Sediments (mg/kg)	Chemical-specific
IRc=	Child Ingestion Rate (mg/day)	200
EFc=	Child Exposure Frequency (days/year)	34
EDc=	Child Exposure Duration (years)	5
BWc=	Child Body Weight (kg)	15.1
IRa=	Adult Ingestion Rate (mg/day)	100
EFa=	Adult Exposure Frequency (days/year)	4
EDa=	Adult Exposure Duration (years)	25
BWa=	Adult Body Weight (kg)	57.1
CF2 =	Conversion Factor 2 (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	30
CF1 =	Conversion Factor 1 (0.000001 kg/mg)	0.000001
SF =	Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-27

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(CURRENT USE SCENARIO)

			NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	ABS (unitless)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals										
Barium	1.48E+03	0.001	1.47E-03	2.17E-06	4.90E-03	4.44E-04	2.93E-04	4.35E-07		
Cadmium	2.02E+01	0.001	1.47E-03	2.96E-08	1.00E-05	2.96E-03	2.93E-04	5.91E-09		
Chromium	1.34E+02	0.001	1.47E-03	1.96E-07	6.00E-05	3.26E-03	2.93E-04	3.92E-08		
Semivolatile Organics										
Benzo(a)pyrene	8.20E-02	0.01	1.47E-02	1.20E-09			2.93E-03	2.41E-10	2.35E+01	5.66E-09
					HAZARD INDEX =	6.66E-03			TOTAL CANCER RISK =	5.66E-09

Equations

HIF = {[(SAc x EFc x EDc x ABS) / BWc + (SAa x EFa x EDa x ABS) / BWa] x AF} / (AT x CF2)
CDI = CS x HIF x CF1
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Values
HIF =	Human Intake Factor (mg/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Chemical-specific
CS =	Concentration in Sediments (mg/kg)	Chemical-specific
SAc=	Child Skin Surface Area Available for Contact (cm^2)	6,500
EFc=	Child Exposure Frequency (days/year)	17
EDc=	Child Exposure Duration (years)	5
BWc=	Child Body Weight (kg)	15.1
SAa=	Adult Skin Surface Area Available for Contact (cm^2)	2,800
EFa=	Adult Exposure Frequency (days/year)	2
EDa=	Adult Exposure Duration (years)	9
BWa=	Adult Body Weight (kg)	57.1
AF=	Adherence Factor (mg/cm^2-day)	0.2
ABS=	Absorption Factor (unitless)	Chemical-type specific
CF2 =	Conversion Factor 2 (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	14
CF1 =	Conversion Factor 1 (0.000001 kg/mg)	1.00E-06
SF =	Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-28

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(CURRENT USE SCENARIO)

			NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	ABS (unitless)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals										
Barium	4.55E+03	0.001	8.06E-03	3.67E-05	4.90E-03	7.49E-03	3.45E-03	1.57E-05		
Cadmium	5.20E+01	0.001	8.06E-03	4.19E-07	1.00E-05	4.19E-02	3.45E-03	1.80E-07		
Chromium	2.69E+02	0.001	8.06E-03	2.17E-06	6.00E-05	3.61E-02	3.45E-03	9.29E-07		
Semivolatile Organics										
Benzo(a)pyrene	8.20E-02	0.01	8.06E-02	6.61E-09			3.45E-02	2.83E-09	2.35E+01	6.67E-08
				HAZARD INDEX =		8.55E-02			TOTAL CANCER RISK =	6.67E-08

Equations

HIF = {[(SAc x EFc x EDc x ABS) / BWc + (SAa x EFa x EDa x ABS) / BWa] x AF} / (AT x CF2)

CDI = CS x CF1 x HIF

Hazard Quotient = CDI / RfD

Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
HIF= Human Intake Factor (mg/kg-day)	Calculated
CDI= Chronic Daily Intake (mg/kg-day)	Chemical-specific
CS= Concentration in Sediments (mg/kg)	Chemical-specific
SAc= Child Skin Surface Area Available for Contact (cm^2)	6,500
EFc= Child Exposure Frequency (days/year)	34
EDc= Child Exposure Duration (years)	5
BWc= Child Body Weight (kg)	15.1
SAa= Adult Skin Surface Area Available for Contact (cm^2)	8,620
EFa= Adult Exposure Frequency (days/year)	4
EDa= Adult Exposure Duration (years)	25
BWa= Adult Body Weight (kg)	57.1
AF= Adherence Factor (mg/cm^2-day)	1
ABS= Absorption Factor (unitless)	Chemical-type specific
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	30
CF1 = Conversion Factor 1 (0.000001 kg/mg)	1.00E-06
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-29

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
INCIDENTAL INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(FUTURE USE SCENARIO)

		NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	**CS (mg/kg)**	**HIF (mg/kg-dy)**	**CDI (mg/kg-dy)**	**Oral RfD (mg/kg-dy)**	**HAZARD QUOTIENT (unitless)**	**HIF (mg/kg-dy)**	**CDI (mg/kg-dy)**	**Oral SF $(mg/kg\text{-}dy)^{-1}$**	**CANCER RISK (unitless)**
Metals									
Barium	8.01E+02	1.11E-01	8.87E-05	7.00E-02	1.27E-03	2.22E-02	1.77E-05		
Cadmium	1.12E+01	1.11E-01	1.24E-06	1.00E-03	1.24E-03	2.22E-02	2.48E-07		
Chromium	6.95E+01	1.11E-01	7.70E-06	3.00E-03	2.57E-03	2.22E-02	1.54E-06		
Semivolatile Organics									
Benzo(a)pyrene	1.50E-01	1.11E-01	1.66E-08			2.22E-02	3.32E-09	7.30E+00	2.43E-08
			HAZARD INDEX =		5.07E-03		TOTAL CANCER RISK =		2.43E-08

Equations **HIF = [(IRc x EFc x EDc) / BWc + (IRa x EFa x EDa) / BWa]/ (ATx CF2)**
CDI = CS x HIF x CF1
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions		**Values**
Parameter	Human Intake Factor (mg/kg-day)	Calculated
HIF=	Chronic Daily Intake (mg/kg-day)	Calculated
CDI=	Concentration in Sediments (mg/kg)	Chemical-specific
CS=	Child Ingestion Rate (mg/day)	100
IRc=	Child Exposure Frequency (days/year)	17
EFc=	Child Exposure Duration (years)	5
EDc=	Child Body Weight (kg)	15.1
BWc=	Adult Ingestion Rate (mg/day)	10
IRa=	Adult Exposure Frequency (days/year)	2
EFa=	Adult Exposure Duration (years)	9
EDa=	Adult Body Weight (kg)	57.1
BWa=	Conversion Factor 2 (365 days/year)	365
CF2 =	Carcinogenic Averaging Time (years)	70
ATc =	Noncarcinogenic Averaging Time (years)	14
ATnc =	Conversion Factor 1(0.000001 kg/mg)	0.000001
CF1 =	Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
SF =	Reference Dose (mg/kg-day)	Chemical-specific
RfD =		

TABLE A-30

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
INCIDENTAL INGESTION EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(FUTURE USE SCENARIO)

		NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Oral RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Oral SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals									
Barium	1.44E+03	2.22E-01	3.20E-04	7.00E-02	4.57E-03	9.50E-02	1.37E-04		
Cadmium	5.20E+01	2.22E-01	1.15E-05	1.00E-03	1.15E-02	9.50E-02	4.94E-06		
Chromium	2.69E+02	2.22E-01	5.96E-05	3.00E-03	1.99E-02	9.50E-02	2.56E-05		
Semivolatile Organics									
Benzo(a)pyrene	1.50E-01	2.22E-01	3.32E-08			9.50E-02	1.42E-08	7.30E+00	1.04E-07
				HAZARD INDEX =	3.60E-02			TOTAL CANCER RISK =	1.04E-07

Equations

HIF = [(IRc x EFc x EDc) / BWc + (IRa x EFa x EDa) / BWa]/ (ATx CF2)
CDI = CS x HIF x CF1
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
HIF= Human Intake Factor (mg/kg-day)	Calculated
CDI= Chronic Daily Intake (mg/kg-day)	Calculated
CS= Concentration in Sediments (mg/kg)	Chemical-specific
IRc= Child Ingestion Rate (mg/day)	200
EFc= Child Exposure Frequency (days/year)	34
EDc= Child Exposure Duration (years)	5
BWc= Child Body Weight (kg)	15.1
IRa= Adult Ingestion Rate (mg/day)	100
EFa= Adult Exposure Frequency (days/year)	4
EDa= Adult Exposure Duration (years)	25
BWa= Adult Body Weight (kg)	57.1
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	30
CF1 = Conversion Factor 1 (0.000001 kg/mg)	0.000001
SF = Slope Factor $((mg/kg\text{-}day)^{-1})$	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-31

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - AVERAGE EXPOSURE
(FUTURE USE SCENARIO)

			NON-CANCER				CANCER			
CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	ABS (unitless)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Dermal RfD (mg/kg-dy)	HAZARD QUOTIENT (unitless)	HIF (mg/kg-dy)	CDI (mg/kg-dy)	Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals										
Barium	8.01E+02	0.001	1.47E-03	1.17E-06	4.90E-03	2.40E-04	2.93E-04	2.35E-07		
Cadmium	1.12E+01	0.001	1.47E-03	1.64E-08	1.00E-05	1.64E-03	2.93E-04	3.28E-09		
Chromium	6.95E+01	0.001	1.47E-03	1.02E-07	6.00E-05	1.70E-03	2.93E-04	2.04E-08		
Semivolatile Organics										
Benzo(a)pyrene	1.50E-01	0.01	1.47E-02	2.20E-09			2.93E-03	4.40E-10	2.35E+01	1.04E-08
					HAZARD INDEX =	3.58E-03			TOTAL CANCER RISK =	1.04E-08

Equations

HIF = {[(SAc x EFc x EDc x ABS) / BWc + (SAa x EFa x EDa x ABS) / BWa] x AF} / (AT x CF2)
CDI = CS x HIF x CF1
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter		Values
HIF =	Human Intake Factor (mg/kg-day)	Calculated
CDI =	Chronic Daily Intake (mg/kg-day)	Chemical-specific
CS =	Concentration in Sediments (mg/kg)	Chemical-specific
SAc=	Child Skin Surface Area Available for Contact (cm^2)	6,500
EFc=	Child Exposure Frequency (days/year)	17
EDc=	Child Exposure Duration (years)	5
BWc=	Child Body Weight (kg)	15.1
SAa=	Adult Skin Surface Area Available for Contact (cm^2)	2,800
EFa=	Adult Exposure Frequency (days/year)	2
EDa=	Adult Exposure Duration (years)	9
BWa=	Adult Body Weight (kg)	57.1
AF=	Adherence Factor (mg/cm^2-day)	0.2
ABS=	Absorption Factor (unitless)	Chemical-type specific
CF2 =	Conversion Factor 2 (365 days/year)	365
ATc =	Carcinogenic Averaging Time (years)	70
ATnc =	Noncarcinogenic Averaging Time (years)	14
CF1 =	Conversion Factor 1 (0.000001 kg/mg)	1.00E-06
SF =	Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD =	Reference Dose (mg/kg-day)	Chemical-specific

TABLE A-32

TINKER AFB SITE - OFF-BASE EAST SOLDIER CREEK
DERMAL EXPOSURE TO CHEMICALS IN SEDIMENT DUE TO WADING AND SWIMMING
OFF-BASE CHILD AND ADULT RESIDENT - RME
(FUTURE USE SCENARIO)

CHEMICALS OF POTENTIAL CONCERN	CS (mg/kg)	ABS (unitless)	NON-CANCER HIF (mg/kg-dy)	NON-CANCER CDI (mg/kg-dy)	NON-CANCER Dermal RfD (mg/kg-dy)	NON-CANCER HAZARD QUOTIENT (unitless)	CANCER HIF (mg/kg-dy)	CANCER CDI (mg/kg-dy)	CANCER Dermal SF $(mg/kg\text{-}dy)^{-1}$	CANCER RISK (unitless)
Metals										
Barium	1.44E+03	0.001	8.06E-03	1.16E-05	4.90E-03	2.38E-03	3.45E-03	4.99E-06		
Cadmium	5.20E+01	0.001	8.06E-03	4.19E-07	1.00E-05	4.19E-02	3.45E-03	1.80E-07		
Chromium	2.69E+02	0.001	8.06E-03	2.17E-06	6.00E-05	3.61E-02	3.45E-03	9.29E-07		
Semivolatile Organics										
Benzo(a)pyrene	1.50E-01	0.01	8.06E-02	1.21E-08			3.45E-02	5.18E-09	2.35E+01	1.22E-07
					HAZARD INDEX =	8.04E-02			TOTAL CANCER RISK =	1.22E-07

Equations

HIF = {[(SAc x EFc x EDc x ABS) / BWc + (SAa x EFa x EDa x ABS) / BWa] x AF} / (AT x CF2)
CDI = CS x CF1 x HIF
Hazard Quotient = CDI / RfD
Cancer Risk = CDI x Slope Factor

Exposure Assumptions

Parameter	Values
HIF= Human Intake Factor (mg/kg-day)	Calculated
CDI= Chronic Daily Intake (mg/kg-day)	Chemical-specific
CS= Concentration in Sediments (mg/kg)	Chemical-specific
SAc= Child Skin Surface Area Available for Contact (cm^2)	6,500
EFc= Child Exposure Frequency (days/year)	34
EDc= Child Exposure Duration (years)	5
BWc= Child Body Weight (kg)	15.1
SAa= Adult Skin Surface Area Available for Contact (cm^2)	8,620
EFa= Adult Exposure Frequency (days/year)	4
EDa= Adult Exposure Duration (years)	25
BWa= Adult Body Weight (kg)	57.1
AF= Adherence Factor (mg/cm^2-day)	1
ABS= Absorption Factor (unitless)	Chemical-type specific
CF2 = Conversion Factor 2 (365 days/year)	365
ATc = Carcinogenic Averaging Time (years)	70
ATnc = Noncarcinogenic Averaging Time (years)	30
CF1 = Conversion Factor 1 (0.000001 kg/mg)	1.00E-06
SF = Slope Factor ($(mg/kg\text{-}day)^{-1}$)	Chemical-specific
RfD = Reference Dose (mg/kg-day)	Chemical-specific

APPENDIX B

DETECTION SUMMARIES

APPENDIX B – DETECTION SUMMARIES

TABLE B-1
FIRST EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(0-6 inches bgs), January 1998

	East Soldier Creek												West Soldier Creek						
	QE01	QE02	QE03	QE04	QE05	QE06	QE07	QE08	QE09	QE10	QE11	TR01	QW01	QW02	QW03	QW04	QW05	QW06	QW07
PCBs and Pesticides - Method 8080 (mg/kg)																			
Aroclor 1254		13	3	0.52											3.5	0.063	4.6	1.1	
delta-BHC																0.002			
Semivolatile Organics - Method 8270 (mg/kg)																			
1,2-Dichlorobenzene		0.92	0.76																
1,4-Dichlorobenzene																			
1-Chloronaphthalene							38		1										
2,4-Dimethylphenol									0.062										
2-Chloronaphthalene									0.082										
2-Methylnaphthalene	0.064								0.071										
2-Methylphenol									0.083										
Acenaphthene		1.2	0.34			0.44	2.4	0.56	0.22								0.093		
Acenaphthylene									0.06										
Acetophenone															0.53				
Anthracene	0.14	2.4	0.7			1.1	12	1.1	0.38						0.096		0.29		
Azobenzene									0.053										
Benzidine															0.11		0.089		
Benzo(a)anthracene	0.3	4.4	1.3	0.15		2.6	46	3.2	1.5		0.066		0.047	0.21	0.32		0.57		0.1
Benzo(a)pyrene	0.3	4.4	1.3	0.17		3	63	4.1	2		0.082		0.057	0.29	0.39		0.58	0.042	0.13
Benzo(b)fluoranthene	0.25	3.6	2	0.16		2.3	55	3.9	1.9		0.088		0.049	0.23	0.33		0.4		0.12
Benzo(g,h,i)perylene	0.33	3.3	1	0.14		3.1	60	5.2	1.8		0.074		0.062	0.29	0.42		0.62		0.13
Benzo(k)fluoranthene	0.27	3.7		0.18		2.8	59	3.2	1.8		0.095		0.052	0.27	0.38		0.58	0.054	0.13
Benzoic acid															1.8				
bis(2-Ethylhexyl)phthalate	0.043	16	1	0.08		6.9	5.4	7.3	1.5		0.36			0.11	0.34		0.23	0.38	
Butyl benzyl phthalate																	0.068		
Chrysene	0.35	5	2	0.18		3.7	66	5	2.3		0.12		0.06	0.31	0.42		0.68	0.057	0.14
Di-n-butyl phthalate														0.47	0.058				
Di-n-octyl phthalate		0.51																	
Dibenz(a,h)anthracene	0.074	1.6	0.36			0.79	15	1.2	0.6					0.095	0.13		0.18		
Dibenz(a,j)acridine		0.2							0.085										
Dibenzofuran		0.8	0.36						0.15										
Fluoranthene	1.2	15	5.2	0.32	0.064	8.9	160	12	5		0.35		0.11	0.61	0.88		1.6	0.16	0.25
Fluorene		1.5	0.39			0.52	4.2	0.56	0.19								0.11		
Indeno(1,2,3-cd)pyrene	0.27	3	0.94	0.12		2.6	49	4.2	1.5		0.066		0.05	0.24	0.36		0.49		0.099
Naphthalene		0.5	1				9.4		1.1		0.044								
Phenanthrene	0.82	4.2	4.6	0.12		4.6	70	4.6	3.2		0.15			0.26	0.5		0.97		0.089
Phenol															0.086				
Pyrene	0.85	6.9	2.9	0.21	0.042	5.6	120	8	3.8		0.19		0.08	0.41	0.61		1.2	0.09	0.21
Total Metals - Methods 6010/7060/7471/7740 (mg/kg)																			
Aluminum	2730	4090	1460	1380	6390	3700	2490	9220	670	3650	3270	6480	16300	14700	2320	2070	2910	5080	3470
Antimony											2.9			2.9					
Arsenic	1.5	9.7	5.3	1.2	1.5	3.6	2.2	5.4	0.82	1.7	1.8	1.1	1.8	2.3	0.95	0.63	1.2	1.5	1.2
Barium	1310	1560	1310	663	478	474	199	645	144	367	4550	340	407	479	149	55	368	790	219
Beryllium	0.42				0.67	0.37		0.65		0.29	0.33	0.54	1	1	0.21	0.19	0.2	0.45	0.24
Cadmium	0.71	61.5	9.7	2.1	1.1	10.2	127	42.1	58	52	25.5		2.7	6.2	0.73	2	12.1	2.2	
Calcium	12200	102000	87200	74100	5990	22700	56900	34100	12600	2310	40300	1130	17000	23200	2090	1130	7620	16500	2810
Chromium	9.8	598	377	31.8	32.9	208	994	261	709	201	269	12.5	26.7	74.2	34.9	19.8	85.8	73.4	9
Cobalt	2.8	31.1	13	2.8	5.7	6.8	7.1	11.8	3	3	3.7	4.2	9	10.5	7.3	3.1	9.6	7.3	3.3
Copper	6.5	685	1390	164	7.8	268	173	439	44.4	10.1	28.6	4.3	19.8	32.1	21.5	12.3	19.4	19.2	2.1

TABLE B-1
FIRST EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(0-6 inches bgs), January 1998

	East Soldier Creek												West Soldier Creek						
	QE01	QE02	QE03	QE04	QE05	QE06	QE07	QE08	QE09	QE10	QE11	TR01	QW01	QW02	QW03	QW04	QW05	QW06	QW07
Iron	6720	27000	14700	3590	9970	7160	16900	14300	4050	7500	6650	10900	13900	14400	4800	2550	6590	15000	6090
Lead	4.9	425	1280	47.2	13.5	122	391	121	37	11.2	21.7		37.9	89.7	7	9.2	36.2	17.1	
Magnesium	1080	8700	5740	4000	1740	3180	3110	5200	2100	1590	14900	1090	8480	5460	1590	764	1230	6130	624
Manganese	103	5370	169	171	685	167	191	218	130	158	926	179	514	474	92.4	71.9	228	198	520
Mercury	0.023	1.2	0.4	0.22	0.016		0.53	0.57		0.026	0.052	0.0084	0.035	0.13	0.12	0.044	0.11	0.031	0.031
Molybdenum		62.8	18.2		1.9	24	3.3	34.9		3.3	1.1				1.9		4.2	2.8	
Nickel	6.4	3590	148	8	11.3	58.5	149	83.7	149	13	74.7	9.5	27	95	182	25.6	78.7	29.3	5.7
Potassium	354	251	177	150	737	520	328	1140	97.6	585	461	1010	2580	1930	502	387	426	891	309
Selenium			3.2			0.59		2											
Silver		5.7	2.2			1.7	45.3	4.8	2.7	0.48	8			3.8	4.5	1.3	8.6	0.84	
Sodium								244				158							
Thallium	29.3	53.3	50.1	39		34.4	46.6	61.8				19.6	13.1	25.6			23.9	43.1	
Vanadium	16.9	25.7	92.2	8.3	20.8	32.1	17.2	53.9	9.5	20.8	15.3	22.1	26.4	32.1	11.3	7.8	14.7	26.7	12.4
Zinc	14.9	514	315	62.7	32	278	647	437	64.6	65.6	33.3	9.4	56.2	175	51.8	77.6	103	84.4	12
Volatile Organics - Method 8260 (mg/kg)																			
2-Butanone (MEK)								0.062											
Acetone	0.014	0.044			0.019	0.023	0.024	0.21	0.019	0.011	0.015	0.0095	0.0037	0.089	0.065		0.055	0.0051	0.0028
Acrylonitrile																			
Carbon disulfide		0.01				0.0017		0.004											
Chlorobenzene		0.032				0.0091		0.0099			0.026								
Dichlorodifluoromethane						0.0031		0.0043											
Ethyl methacrylate																			
Ethylbenzene							0.012	0.0026											
Methylene chloride	0.0023	0.0077	0.0029	0.0015	0.0016	0.0031	0.0016	0.0054			0.0015	0.0013	0.0015	0.0022	0.0016	0.0026		0.0019	
Tetrachloroethene								0.0022											
Toluene				0.0019				0.0025											
Trichlorofluoromethane						0.002		0.0035											
Xylenes (total)						0.0048	0.0014	0.0094											

TABLE B-2
FIRST EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(6-12 inches bgs), January 1998

	East Soldier Creek							West Soldier Creek			
	QE02	QE06	QE07	QE08	QE09	QE10	QE11	QW01	QW03	QW04	QW07
PCBs and Pesticides - Method 8080 (mg/kg)											
Aroclor 1254	9								5.4		
delta-BHC											
Semivolatile Organics - Method 8270 (mg/kg)											
1,2-Dichlorobenzene	0.19										
1,4-Dichlorobenzene	0.1										
1-Chloronaphthalene		0.25									
2,4-Dimethylphenol											
2-Chloronaphthalene											
2-Methylnaphthalene											
2-Methylphenol											
Acenaphthene	0.48	0.76	2.2		0.042						
Acenaphthylene											
Acetophenone											
Anthracene	0.77	2	7.7	0.34	0.076				0.065		
Azobenzene											
Benzidine	0.094										
Benzo(a)anthracene	1.4	5	34	0.87	0.31				0.24		
Benzo(a)pyrene	1.3	5.7	39	1.1	0.41		0.15		0.4		
Benzo(b)fluoranthene	1	4.5	40	0.93	0.47						
Benzo(g,h,i)perylene	1.2	4.7	34	1.4	0.41				0.19		
Benzo(k)fluoranthene	1.2	4.3	33	1.1	0.39				0.75		
Benzoic acid											
bis(2-Ethylhexyl)phthalate	1.6	4.2	3	3.1	0.69		0.33		0.84		
Butyl benzyl phthalate											
Chrysene	1.7	6.7	47	1.4	0.51				0.42		
Di-n-butyl phthalate											
Di-n-octyl phthalate											
Dibenz(a,h)anthracene	0.36	1.5	11		0.095						
Dibenz(a,j)acridine			0.94								
Dibenzofuran	0.3	0.35	1.4								
Fluoranthene	4.9	17	100	3.5	1.1		0.054		0.74		

TABLE B-2
FIRST EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(6-12 inches bgs), January 1998

	East Soldier Creek							West Soldier Creek			
	QE02	QE06	QE07	QE08	QE09	QE10	QE11	QW01	QW03	QW04	QW07
Fluorene	0.38	0.87	3.5								
Indeno(1,2,3-cd)pyrene	1.1	4.1	31	1.1	0.33				0.13		
Naphthalene	0.32	0.32	9.4		0.068						
Phenanthrene	2.2	9.4	51	1.5	0.56				0.35		
Phenol											
Pyrene	2.9	8.6	80	2.2	0.85				0.44		
Total Metals - Methods 6010/7060/7471/7740 (mgkg)											
Aluminum	2430	4890	1960	6100	1450	3410	4850	10500	7700	545	7170
Antimony			7.4						5.5		
Arsenic	3	3.6	2.3	2.6	0.97	0.8	1.1	1.8	2.2	0.28	1.4
Barium	599	472	266	486	376	424	433	340	300	34.7	400
Beryllium		0.69		0.58		0.42	0.5	0.93	0.5		0.78
Cadmium	29	12.8	193	48.8	10.6	12.5	7.3	1.5	42.2		0.35
Calcium	70200	23000	64800	16400	7570	931	2280	21900	10200	7000	4060
Chromium	299	169	1830	232	85.8	22.7	57.1	23.6	455	2.2	16.3
Cobalt	12	8.6	5.3	7.8	2.3	4.6	5.7	8.3	78.3	1.3	4.7
Copper	156	313	170	218	9.6	3.2	9.6	18.8	498	1.2	4.6
Iron	9010	10700	14100	9860	4760	8670	6690	12800	9110	896	12100
Lead	306	110	279	72.9	8.4	5.7	13.8	24.3	248		6.3
Magnesium	7880	2880	3490	2990	537	904	1400	10500	3240	347	1640
Manganese	887	222	172	195	415	155	306	703	153	20.5	315
Mercury	0.28	0.31	0.69	0.32	0.054	0.022	0.053	0.014	0.64		0.038
Molybdenum	22.4	14.4	4	10.6					97.3		
Nickel	352	115	175	82.8	25.6	7.5	11.5	23.6	3010	4.5	9.6
Potassium	327	570	285	761	241	581	665	1550	830	165	583
Selenium		0.53			0.4				2.6		
Silver	3.7	3.6	64.5	4.8	0.45		0.6		236		
Sodium											170
Thallium	40.4	40.9	40.7					18.4			
Vanadium	12.9	51.7	16.5	32	5.2	19.7	18.1	24.5	42.5	2.9	23.4
Zinc	139	288	730	216	18.3	17.1	23.9	38.8	924	2.4	15.2
Volatile Organics - Method 8260 (mg/kg)											

TABLE B-2
FIRST EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(6-12 inches bgs), January 1998

	East Soldier Creek							West Soldier Creek			
	QE02	QE06	QE07	QE08	QE09	QE10	QE11	QW01	QW03	QW04	QW07
2-Butanone (MEK)				0.016							
Acetone	0.019	0.021	0.016	0.063	0.0044	0.028	0.012	0.0091	0.0043	0.039	0.0094
Acrylonitrile											
Carbon disulfide	0.0093			0.002							
Chlorobenzene				0.0018			0.015				
Dichlorodifluoromethane											
Ethyl methacrylate									0.0074		
Ethylbenzene			0.06								
Methylene chloride	0.0063	0.002	0.0018	0.0025			0.0012	0.0022	0.0017	0.002	0.0015
Tetrachloroethene											
Toluene							0.0013				
Trichlorofluoromethane											
Xylenes (total)			0.0024								

TABLE B-3
FIRST EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(greater than 12 inches bgs), January 1998

	East Soldier Creek				West Soldier Creek
	QE06	QE07	QE08	QE10	QW07
	(3.5-4.0 feet)	(3.5-4.0 feet)	(3.5-4.0 feet)	(3.5-4.0 feet)	(2.5-3.0 feet)
PCBs and Pesticides - Method 8080 (mg/kg)					
Aroclor 1254					
delta-BHC					
Semivolatile Organics - Method 8270 (mg/kg)					
1,2-Dichlorobenzene					
1,4-Dichlorobenzene			0.11		
1-Chloronaphthalene		4.5	0.3		
2,4-Dimethylphenol					
2-Chloronaphthalene	0.27	0.18	0.23		
2-Methylnaphthalene			0.043		
2-Methylphenol					
Acenaphthene		0.55			
Acenaphthylene					
Acetophenone					
Anthracene	0.21	1.3	0.048		
Azobenzene					
Benzidine					
Benzo(a)anthracene	0.66	3.9	0.099		
Benzo(a)pyrene	0.79	5	0.14		
Benzo(b)fluoranthene	0.74	4.8	0.13		
Benzo(g,h,i)perylene	0.66	5.9	0.17		
Benzo(k)fluoranthene	0.63	4.2	0.11		
Benzoic acid					
bis(2-Ethylhexyl)phthalate	3.3	2.9	2.1		
Butyl benzyl phthalate					
Chrysene	1	5.5	0.18		
Di-n-butyl phthalate					
Di-n-octyl phthalate					
Dibenz(a,h)anthracene		0.28			
Dibenz(a,j)acridine		0.26			
Dibenzofuran		0.35			
Fluoranthene	2.5	14	1.3		
Fluorene		0.71			
Indeno(1,2,3-cd)pyrene	0.63	4.9	0.13		
Naphthalene		2	0.056		
Phenanthrene	1.3	7.1	0.24		
Phenol					
Pyrene	1.4	9.3	0.29		
Total Metals - Methods 6010/7060/7471/7740 (mg/kg)					
Aluminum	4390	3450	5560	2540	7430
Antimony					
Arsenic	1.3	3.1	2.5	0.68	5.4
Barium	477	128	504	317	1310
Beryllium	0.35		0.45	0.37	1.2
Cadmium	8.8	8.4	109	10.5	

TABLE B-3
FIRST EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(greater than 12 inches bgs), January 1998

	East Soldier Creek				West Soldier Creek
	QE06	QE07	QE08	QE10	QW07
	(3.5-4.0 feet)	(3.5-4.0 feet)	(3.5-4.0 feet)	(3.5-4.0 feet)	(2.5-3.0 feet)
Calcium	9150	184000	7920	1130	1460
Chromium	169	58.4	651	48.5	24.8
Cobalt	6.2	3.6	7.6	3.1	8.6
Copper	126	53.7	40.8	2.5	6
Iron	7150	6210	10600	5990	18700
Lead	108	53.9	77.7	5.7	
Magnesium	2400	4560	2250	668	3760
Manganese	192	179	534	68.1	380
Mercury		0.23	0.12	0.028	0.029
Molybdenum	2.4		3.5		
Nickel	32.9	23.3	152	6.4	24.2
Potassium	512	393	732	457	596
Selenium					
Silver	1.5	1.2	7.9		
Sodium			175		1280
Thallium					
Vanadium	19.2	10.1	24.1	14.4	60.3
Zinc	152	74.8	100	13.4	27.8
Volatile Organics - Method 8260 (mg/kg)					
2-Butanone (MEK)	0.015				
Acetone	0.044	0.0082	0.058	0.036	0.0066
Acrylonitrile	0.014				
Carbon disulfide					
Chlorobenzene	0.03		1		
Dichlorodifluoromethane					
Ethyl methacrylate					
Ethylbenzene		0.0087			
Methylene chloride	0.0029	0.0027	0.009	0.0014	0.0023
Tetrachloroethene					
Toluene					
Trichlorofluoromethane					
Xylenes (total)	0.0028				

TABLE B-4
SECOND EVENT FOURTH YEAR SAMPLING DETECTIONS
(0-6 inches bgs), July, 1998

	East Soldier Creek												West Soldier Creek		
	QE01-1201	QE02-1201	QE03-1201	QE04-1201	QE05-1201	QE06-1201	QE07-1201	QE08-1201	QE09-1201	QE10-1201	QE11-1201	TR01-1201	QW05-1201	QW06-1201	QW07-1201
PCBs & Pesticides - Method 8080A (ug/kg)															
4,4'-DDD				5.7											
4,4'-DDE		100													
4,4'-DDT															14
Aldrin		110													
Aroclor 1254	980	4700	3100		530						25		980	280	
Endosulfan II		590		5.7											
gamma-Chlordane		25													
Semivolatile Organic Compounds - Method 8270B (ug/kg)															
1,2-Dichlorobenzene									1400						
1,3-Dichlorobenzene									150						
1,4-Dichlorobenzene									890						
1-Chloronaphthalene							890								
2-Chloronaphthalene							78								
2-Methylnaphthalene		67		53			95								
Acenaphthene		340					420								
Acenaphthylene		90					48								
Anthracene		610			310	430	700	1100							
Benzo(a)anthracene		2100	83		1100	2600	2300	8000	100			400	89		64
Benzo(a)pyrene		2100	120		960	2500	2300	9300	94			550	88		100
Benzo(b)fluoranthene		2000	120		880	2800	2100	13000	93			690	65		86
Benzo(ghi)perylene		1800	120		700	2900	1800	8900	63			530	48		95
Benzo(k)fluoranthene		1700	92		940	2100	2100	8300	93			520	90		120
bis(2-Ethylhexyl) phthalate	190	230	280	220	300	3200	1900	5200	2000			200	110	49	170
Chrysene		2500	130		1400	3500	2900	12000	100			610	86		130
Dibenz(a,h)anthracene		600				380	280	2700				130			
Dibenzofuran		220					220								
Di-n-butyl phthalate							53								
Di-n-octyl phthalate									130						
Fluoranthene	310	6200	230	55	2700	7500	7700	27000	820			1200	240		190
Fluorene		350		49	170		370	420							
Indeno(1,2,3-cd)pyrene		1600	99		600	2100	1600	7900	62			470	63		88
Naphthalene		330			220		3900		90						
Phenanthrene		4300	65		1800	3400	5000	7100	54			370	140		55
Phenol															
Pyrene	250	5000	260		2400	5800	5900	20000	340			1200	280		190
Total Metals - Methods 6010B/7471A (mg/kg)															
Aluminum	4230	2950	1180	8550	1560	5600	8260	11900	1420	5280	7470	6710	4220	2250	9950
Antimony	7.2	2.6			3		3.4			5.2			2.5	3.9	
Arsenic	2.8	3.6	2.6	7.4	1.1	3.4	2.5	5.6	1.1	2.8	2.3	3.2	12.2	3.1	3.1
Barium	584	374	601	890	308	528	530	792	178	604	411	407	350	654	887
Beryllium	0.43	0.3	0.14	0.97	0.23	0.48	0.63	0.8	0.17	0.46	0.54	0.52	0.53	0.3	0.67
Cadmium	2.8	2.3	1.9		1.8	15.7	291	42	13.7	1.4	1.7	10.8	2.5	0.74	
Calcium	75700	41100	96700	1850	87400	19700	16100	28700	62400	16700	3190	7170	49700	57100	3960
Chromium	25.2	107	249	21.6	61.4	252	732	314	218	43.2	20.8	80.7	90.6	25.8	15.5
Cobalt	5.9	5.5	4.8	23.9	2.7	8.1	9	12.3	2	4.8	4	5.5	6.5	3.2	5.8
Copper	169	121	142	11.7	48.4	225	113	514	15.8	11	7.6	32.2	10.8	4.3	5.8
Iron	8080	8120	8970	18500	4060	9170	11500	17900	5270	10500	10800	14500	12500	4990	12500
Lead	35.4	52.6	29.2	21.9	21.7	108	158	121	41.8	7.6	6.5	24	14.4	5.9	6.3
Magnesium	6680	3960	8640	1930	4080	3840	3300	5190	8470	7750	2020	3250	5330	17900	1200
Manganese	1030	495	219	1390	303	187	380	252	217	633	259	343	257	637	398

TABLE B-4
SECOND EVENT FOURTH YEAR SAMPLING DETECTIONS
(0-6 inches bgs), July, 1998

	East Soldier Creek												West Soldier Creek		
	QE01-1201	QE02-1201	QE03-1201	QE04-1201	QE05-1201	QE06-1201	QE07-1201	QE08-1201	QE09-1201	QE10-1201	QE11-1201	TR01-1201	QW05-1201	QW06-1201	QW07-1201
Mercury	0.085	0.22	0.16		0.21	0.5	0.25	1.1	0.65			0.079			
Molybdenum	1.6	12.2	7.1	6.5	1.1	14.6	2.8	9.2	5.8	3.1	1.8	0.9	2.2		
Nickel	11.9	39.1	84.5	16.7	9.9	85.2	300	110	82.5	15.5	11.4	21.3	35.3	8.3	9.4
Potassium	595	475	255	1150	231	830	1080	1720	204	782	955	1010	712	367	1040
Selenium	0.61	1.2	1.3	1.5	0.37	1.3	1.2	2.3	0.76	0.8	0.77	1.2	3.1		1
Silver						2.1	16.3	5	6.5			1.1	1.3		
Sodium				130						162	181				177
Thallium			0.43	1.7			1.3	1		0.68	0.62	1.1	8.6		1.9
Vanadium	17.1	20.3	13.6	41.7	10.5	26.6	27.1	47.6	7.4	19.9	20.3	21.4	18.9	9.5	21.3
Zinc	52.6	50	92.4	17.6	54.3	299	297	489	25	23.8	19.7	70.8	46	16.7	21.5
Volatile Organic Compounds - Method 8260A (mg/kg)															
2-Butanone (MEK)						0.027		0.017	0.059						
Acetone	0.033	0.007			0.0048	0.11	0.022	0.072	0.13	0.036	0.012				
Chlorobenzene							0.003	0.063	2						
Methylene chloride	0.0069														

TABLE B-5
SECOND EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(6-12 inches bgs), July 1998

	East Soldier Creek									W. Soldier
	QE01-1202	QE04-1202	QE05-1202	QE06-1202	QE07-1202	QE08-1202	QE09-1202	QE10-1202	QE11-1202	QW07-1202
PCBs & Pesticides - Method 8080A (ug/kg)										
4,4'-DDD										
4,4'-DDE										
4,4'-DDT										
Aldrin										
Aroclor 1254	76		380							
Endosulfan II										
gamma-Chlordane										
Semivolatile Organic Compounds - Method 8270B (ug/kg)										
1,2-Dichlorobenzene						73	11000			
1,3-Dichlorobenzene							1100			
1,4-Dichlorobenzene						140	6300			
1-Chloronaphthalene					680	3700				
2-Chloronaphthalene				350		710				
2-Methylnaphthalene					57	1600				
Acenaphthene	1300			240	50	240				
Acenaphthylene						52				
Anthracene	5000		360	420	100	280				
Benzo(a)anthracene	10000		1400	2100	540	1100				
Benzo(a)pyrene	7200		1300	2400	660	1100				
Benzo(b)fluoranthene	7300		1500	2500	770	1300				
Benzo(ghi)perylene	4000		1300	2600	720	720				
Benzo(k)fluoranthene	5900		1300	2200	590	790				
bis(2-Ethylhexyl) phthalate			170	1400	1100	5500	1200			
Chrysene	12000		1600	3000	830	1300				
Dibenz(a,h)anthracene			310	620	160	280				
Dibenzofuran	750					200				
Di-n-butyl phthalate										
Di-n-octyl phthalate										
Fluoranthene	26000		3500	7400	1800	5600	1100			
Fluorene	1600			210	64	360				
Indeno(1,2,3-cd)pyrene	3900		1000	2100	540	690				
Naphthalene	360				1500	3400	180			
Phenanthrene	16000		1800	4500	680	2400	180			
Phenol						46				
Pyrene	19000		2700	4900	1300	2700	350			

TABLE B-5
SECOND EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(6-12 inches bgs), July 1998

	East Soldier Creek									W. Soldier
	QE01-1202	QE04-1202	QE05-1202	QE06-1202	QE07-1202	QE08-1202	QE09-1202	QE10-1202	QE11-1202	QW07-1202
Total Metals - Methods 6010B/7471A (mg/kg)										
Aluminum	3460	7800	1890	8690	6520	7810	2840	7710	7950	4630
Antimony	4						4.1			
Arsenic	1.9	4.4	3.5	3.2	1.2	3	2.8	2.3	2.6	1.3
Barium	914	722	366	536	198	444	658	289	361	110
Beryllium	0.36	0.73	0.3	0.66	0.43	0.53	0.29	0.54	0.59	0.3
Cadmium	2.6		2.1	29.7	33.3	115	19.2			
Calcium	59200	1500	45000	16100	1830	7120	42300	1860	2360	3460
Chromium	51.2	23.9	106	331	127	734	135	12.4	12.7	7.6
Cobalt	4.6	8.9	7.9	7.9	4.1	10.1	3.8	3.7	5.2	1.9
Copper	10.3	14.4	65.7	94.5	20.1	57.6	15.9	6.8	7.6	2.6
Iron	6500	14700	7810	12000	8200	12300	7070	10100	11400	6270
Lead	86.2	14.5	42.6	188	22.6	75.5	57.3	4.6	5.6	
Magnesium	3760	1580	4220	5940	1930	2280	10500	1490	1690	864
Manganese	302	898	747	294	120	456	312	131	665	80
Mercury	0.045		0.18	1	0.058	0.57	2.9			
Molybdenum		3.1	12.4	3.5		3.4	14.6	2	1.3	
Nickel	9.3	10.7	39.4	51	116	184	45.8	10.1	9.9	4.6
Potassium	518	1060	334	1280	932	1130	402	1080	1010	499
Selenium	0.55	1.6	1.3	0.83	0.62	1.6	0.63	1.2	1	0.99
Silver				2.6	1.9	12	4.8			
Sodium		174		164		163			194	
Thallium		0.98		0.68	0.79	1.2	0.8	0.77	1.3	
Vanadium	14.4	31.8	20.8	26.2	11	23.9	12	19.2	20.1	11.4
Zinc	264	17.9	50.1	215	53.1	116	34.5	14.6	15.5	9.5
Volatile Organic Compounds - Method 8260A (mg/kg)										
2-Butanone (MEK)				0.012						
Acetone		0.0083		0.049	0.012	0.2	0.57	0.046	0.044	
Chlorobenzene				0.0037	0.0072	3.1	20	0.0018	0.0024	
Methylene chloride										

TABLE B-6
SECOND EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(greater than 12 inches bgs), July 1998

	East Soldier Creek		W. Soldier
	QE07-1203	QE10-1203	QW07-1203
	1.0-2.0 feet bgs	3.0-4.0 feet bgs	2.0-2.5 feet bgs
PCBs & Pesticides - Method 8080A (ug/kg)			
4,4'-DDD			
4,4'-DDE			
4,4'-DDT			
Aldrin			
Aroclor 1254			
Endosulfan II			
gamma-Chlordane			
Semivolatile Organic Compounds - Method 8270B (ug/kg)			
1,2-Dichlorobenzene			
1,3-Dichlorobenzene			
1,4-Dichlorobenzene			
1-Chloronaphthalene	50		
2-Chloronaphthalene			
2-Methylnaphthalene			
Acenaphthene			
Acenaphthylene			
Anthracene			
Benzo(a)anthracene	160		
Benzo(a)pyrene	60		
Benzo(b)fluoranthene	180		
Benzo(ghi)perylene	190		
Benzo(k)fluoranthene	200		
bis(2-Ethylhexyl) phthalate	160		
Chrysene	270		
Dibenz(a,h)anthracene			
Dibenzofuran			
Di-n-butyl phthalate			
Di-n-octyl phthalate			
Fluoranthene	510		44
Fluorene			
Indeno(1,2,3-cd)pyrene	160		
Naphthalene	77		
Phenanthrene	160		
Phenol			
Pyrene	380		70
Total Metals - Methods 6010B/7471A (mg/kg)			
Aluminum	5420	3200	8980
Antimony			
Arsenic	2.2	1.6	1.8
Barium	211	249	248
Beryllium	0.43	0.3	0.47
Cadmium	18.9		
Calcium	2070	914	1780
Chromium	61.9	7.9	14

TABLE B-6
SECOND EVENT FOURTH YEAR SEDIMENT SAMPLING DETECTIONS
(greater than 12 inches bgs), July 1998

	East Soldier Creek		W. Soldier
	QE07-1203	QE10-1203	QW07-1203
	1.0-2.0 feet bgs	3.0-4.0 feet bgs	2.0-2.5 feet bgs
Cobalt	3.1	2	2.8
Copper	10.9	3.8	3.4
Iron	9830	5640	9710
Lead	12.2	4.3	5.7
Magnesium	1550	736	1030
Manganese	1970	93.7	131
Mercury	0.042		
Molybdenum			
Nickel	42	5	7.9
Potassium	816	509	864
Selenium	1.2	0.86	1.2
Silver	0.88		
Sodium		168	102
Thallium			0.93
Vanadium	15	11.3	16.4
Zinc	30.6	9.4	13.7
Volatile Organic Compounds - Method 8260A (mg/kg)			
2-Butanone (MEK)			
Acetone	0.0072	0.03	0.016
Chlorobenzene		0.0027	
Methylene chloride			

TABLE B-7
FIRST EVENT FOURTH YEAR SURFACE WATER SAMPLING DETECTIONS
January 1998

	East Soldier Creek											West Soldier Creek				
	QE01	QE02	QE03	QE04	QE05	QE06	QE07	QE08	QE09	QE10	QE11	QW03	QW04	QW05	QW06	QW07
Dissolved Metals - Methods 6010/6020 (mg/L)																
Aluminum	0.011		0.0065	0.017	0.0053		0.063		0.03	0.0066	0.0075	0.0055	0.013	0.0075	0.024	
Antimony					0.00076	0.00055		0.0005	0.00041							
Barium	0.4	0.41	0.42	0.42	0.4	0.41	0.42	0.42	0.41	0.4	0.39	0.36	0.26	0.38	0.37	0.22
Cadmium		0.00006	0.000069	0.000049	0.000065	0.00017	0.00034	0.00026	0.00033	0.00036		0.00071	0.00075	0.00026	0.00025	
Calcium	44.1	53.3	54.3	45.8	50.2	54.2	47.9	53.5	53.6	52	52.5	49.7	55.5	57.8	56.3	69.2
Chromium	0.022	0.023	0.023	0.021	0.022	0.021	0.023	0.021	0.022	0.022	0.023	0.024	0.022	0.025	0.023	0.019
Cobalt	0.000096	0.00013	0.00014	0.00011	0.00013	0.00015	0.000098	0.00015	0.00017	0.00017	0.00024	0.00058	0.00014	0.00014	0.00014	0.00045
Copper	0.0015	0.061	0.056	0.019	0.016	0.011	0.0096	0.011	0.012	0.01	0.0089	0.015	0.0022	0.0031	0.0026	0.0023
Iron										0.032	0.16					
Lead	0.0001	0.000082	0.00013	0.000095	0.00011	0.00033		0.00026	0.00028		0.00034	0.000073				
Magnesium	21.1	25.8	26.4	22.8	24	25.4	22.8	25.3	25.5	26.3	26.1	21.5	18.4	25	24	12.7
Manganese	0.0033	0.004	0.0044	0.0038	0.0039	0.0095	0.0003	0.0096	0.012	0.013	0.11	0.0019	0.0022	0.0026	0.0025	0.14
Molybdenum		0.0012	0.0013			0.0011		0.0011	0.0011	0.0012	0.0013	0.0051	0.012	0.0035	0.0038	0.0021
Nickel	0.0026	0.0036	0.0038	0.0031	0.0032	0.0038	0.0029	0.0037	0.0038	0.0039	0.0051	0.033	0.018	0.006	0.0059	0.0068
Potassium	1.9	2.2	1.8	2.1	2	2.2	1.7	1.9	2.1	1.8	1.7	1.5	1.6	1.5	1.5	
Selenium	0.0023	0.0032	0.0028	0.0033	0.0019	0.0016	0.0022	0.0016	0.0016	0.0014	0.0016	0.00081	0.00061	0.0015	0.0012	0.0021
Silver				0.000085		0.000078	0.0003	0.00013	0.00028							
Sodium	15	22.7	26.4	23.1	20.8	20	12.1	20.7	21.2	23.1	24	14.4	14.9	24.6	24.7	23.6
Vanadium	0.017	0.017	0.017	0.017	0.017	0.016	0.017	0.017	0.017	0.017	0.015	0.012	0.0077	0.017	0.016	0.0064
Zinc	0.022	0.026	0.025	0.024	0.022	0.022	0.031	0.02	0.021	0.02	0.022	0.065	0.037	0.03	0.028	0.047
Semivolatile Organics - Method 8270 (mg/L)																
bis(2-Ethylhexyl)phthalate	0.0018	0.14		0.0038										0.0036		
Di-n-butyl phthalate			0.0015													
Total Metals - Methods 6010/6020/7060/7470 (mg/L)																
Aluminum	0.37	0.012	0.0089	0.024	0.07	0.041	0.006	0.036	0.041	0.04	0.057	0.035	0.087	0.023	0.029	0.037
Antimony					0.00069	0.0005		0.00048	0.00046	0.00032	0.0002		0.00022		0.00064	
Barium	0.4	0.39	0.4	0.4	0.39	0.39	0.4	0.4	0.39	0.39	0.38	0.34	0.26	0.36	0.36	0.22
Beryllium	0.000068															
Cadmium	0.00014	0.000087	0.00011	0.000077	0.00011	0.00024	0.00038	0.00043	0.001	0.00064	0.0011	0.00077	0.00094	0.0003	0.0003	0.00012
Calcium	45.1	53.7	55.3	48.6	45.4	46.9	44.9	47.7	47.1	48.8	49.3	46.4	50.7	53.2	52.6	62.9
Chromium	0.0065	0.0093	0.01	0.0074	0.0072	0.0059	0.0064	0.0064	0.022	0.0065	0.0072	0.0039	0.0036	0.0038	0.0041	0.00026
Cobalt	0.00045	0.00013	0.00014	0.00013	0.00018	0.00018	0.000092	0.00018	0.0002	0.00019	0.00027	0.00063	0.0002	0.00016	0.00016	0.00051
Copper	0.0058	0.076	0.075	0.027	0.027	0.022	0.0084	0.021	0.02	0.02	0.017	0.019	0.006	0.0054	0.0055	0.006
Iron	0.7	0.066	0.068	0.025	0.11	0.1		0.09	0.14	0.12	0.26	0.059	0.1	0.052	0.028	0.21
Lead	0.0028	0.0005	0.00058	0.00062	0.001	0.0017	0.00037	0.0023	0.0024	0.0012	0.0012	0.0005	0.00075	0.00057	0.00037	0.00058
Magnesium	20.3	25.4	26.5	23	21.4	21.9	21.4	22.4	22.2	22.8	23	18.7	15.9	22	21.8	11.5
Manganese	0.048	0.0052	0.0056	0.0067	0.012	0.012	0.00086	0.013	0.016	0.017	0.12	0.0044	0.0065	0.0061	0.0039	0.16
Mercury											0.000046		0.000075	0.000064	0.000044	
Molybdenum	0.00029	0.0011	0.0012	0.00059	0.00077	0.00099	0.00018	0.001	0.001	0.0011	0.0012	0.005	0.011	0.0032	0.0035	0.002
Nickel	0.0035	0.0033	0.0036	0.003	0.0033	0.0033	0.0026	0.0037	0.0039	0.0037	0.0051	0.036	0.019	0.0061	0.0062	0.0066
Potassium	1.8	1.9	1.7	1.7	1.7	1.7	1.4	1.7	1.7	1.8	1.7	1.3	1.8	1.3	1.3	4.1
Selenium	0.0005	0.0022	0.0022	0.00096	0.0012	0.0012	0.00058	0.0014	0.0012	0.0013	0.0039	0.00063	0.00034	0.00097	0.0011	0.002
Silver															0.000081	
Sodium	12.8	21.4	25.4	20.4	17.5	16.5	11.4	17.9	18.3	18.7	19.8	10.7	10.9	20.8	20.6	21.3
Thallium	0.000032	0.000037	0.000036	0.000039	0.00004	0.000033		0.000035	0.000042	0.000043	0.000041	0.000028	0.000033	0.000036	0.000038	0.000044

TABLE B-7
FIRST EVENT FOURTH YEAR SURFACE WATER SAMPLING DETECTIONS
January 1998

	East Soldier Creek											West Soldier Creek				
	QE01	QE02	QE03	QE04	QE05	QE06	QE07	QE08	QE09	QE10	QE11	QW03	QW04	QW05	QW06	QW07
Vanadium	0.014	0.013	0.013	0.013	0.013	0.012	0.013	0.012	0.012	0.012	0.011	0.0063	0.0026	0.011	0.011	0.0014
Zinc	0.035	0.04	0.038	0.034	0.039	0.032	0.04	0.038	0.03	0.031	0.032	0.079	0.048	0.039	0.034	0.062
Volatile Organics - Method 8260 (mg/L)																
Acetone	0.0038			0.0031					0.0033	0.0032						0.0051
Bromoform				0.001	0.0014		0.0013									
Methylene chloride	0.0014	0.0014	0.0013	0.0013	0.0012	0.0013	0.001	0.0017	0.0011	0.0018	0.0029	0.0023	0.0031	0.0026	0.0013	
Tetrachloroethene									0.0015							0.0014
Wet Chemistry - Methods 130.2/160.1/160.2/300.0/310.1/410.4/415.1 (mg/L)																
Alkalinity, Bicarb. as CaCO3 at pH 4.5	198	171	165	190	187	191	190	184	177	174	197	197	195	225	216	199
Alkalinity, Carb. as CaCO3 at pH 8.3							9.4	5.9	13.4	17.2				7.5	13.3	
Alkalinity, Total as CaCO3 at pH 4.5	198	171	165	190	187	191	199	189	191	191	197	197	195	232	229	199
Chemical Oxygen Demand (Regular)		11.8	9.9			29.9										
Chloride	7.5	15.1	22.4	19.4	15.1	11.5	6.9	13.5	13.4	13.5	14.2	6.4	6.6	9	9.1	10.5
Hardness as CaCO3	192	224	234	204	202	208	188	214	210	210	216	192	192	226	220	204
Sulfate	6	83.1	88.7	33.3	30.4	36.8	4.9	47.5	45.3	39.9	39	4.6	5.7	10.2	10.2	32.1
Total Dissolved Solids	214	318	325	274	264	262	208	283	271	277	244	235	200	292	289	271
Total Organic Carbon	0.29	4.1	3.9	1.4	1.2	1.5	0.53	2.2	2.9	2.8	2.7	1	2.1	1.3	1.5	4.8
Total Suspended Solids	68.8				6.8	2.4		4	4.8	2.4	1.6	2.8	31.6	3.2		8.4

TABLE B-8
SECOND EVENT FOURTH YEAR SURFACE WATER SAMPLING DETECTIONS
July, 1998

	East Soldier Creek											West Soldier Creek		
	QE01-1201	QE02-1201	QE03-1201	QE04-1201	QE05-1201	QE06-1201	QE07-1201	QE08-1201	QE09-1201	QE10-1201	QE11-1201	QW05-1201	QW06-1201	QW07-1201
PCBs & Pesticides - Method 8080A (ug/L)														
Dieldrin							0.029							
Heptachlor							0.024							
Semivolatile Organic Compounds - Method 8270B (ug/L)														
Di-n-butyl phthalate													2	
Total Metals - Methods 6010B/6020/7471A (mg/L)														
Aluminum	0.15	0.026	0.038	0.029	0.05	0.88	0.59	0.16	0.64	0.5	0.42	0.32	0.45	0.32
Antimony	0.00022					0.00022	0.00035	0.00024	0.00047	0.00069	0.0019	0.00034	0.0018	
Arsenic													0.0061	
Barium	0.52	0.46	0.47	0.45	0.48	0.5	0.44	0.45	0.43	0.46	0.44	0.43	0.43	0.34
Beryllium											0.000081		0.00012	
Cadmium	0.00021	0.00012	0.00015	0.00017	0.00021	0.002	0.01	0.0009	0.0067	0.0027	0.0023	0.00059	0.00079	
Calcium	48.5	41.5	42.5	41	43.6	42.4	34.2	41.4	39.9	42	41.4	48	47	47
Chromium	0.0053	0.0049	0.0082	0.0047	0.0049	0.018	0.02	0.0058	0.025	0.009	0.012	0.0076	0.012	0.0046
Cobalt	0.00023	0.00025	0.00029	0.00028	0.00029	0.00089	0.00068	0.00042	0.00078	0.00046	0.00042	0.0005	0.00062	0.00033
Copper	0.033	0.14	0.13	0.12	0.099	0.068	0.04	0.03	0.04	0.013	0.011	0.0026	0.0029	0.0053
Iron	0.21					1	0.83	0.36	0.84	1.2	0.58	0.42	0.59	0.34
Lead	0.00087	0.001	0.0014	0.00084	0.0011	0.0091	0.0091	0.0027	0.0063	0.0038	0.0029	0.0015	0.0019	0.00028
Magnesium	24.1	19.9	20.4	19.5	20.9	20.4	18.9	20.1	20	20.8	20.6	21.2	23.4	20.9
Manganese	0.015	0.0057	0.007	0.0056	0.0065	0.039	0.027	0.022	0.053	0.063	0.092	0.045	0.047	0.068
Molybdenum	0.0018	0.00066	0.00077	0.00088	0.0011	0.003	0.00057	0.0023	0.0036	0.0028	0.0031	0.0017	0.0027	0.0003
Nickel	0.002	0.0027	0.0036	0.0027	0.0029	0.0078	0.009	0.0042	0.015	0.0049	0.0067	0.0039	0.0058	0.002
Potassium	2	1.1	1.1	0.95	1	1.3	1.3	1.3	1.5	1.4	1.3	4.5	1.3	4.7
Selenium	0.0014	0.00084	0.00071	0.00089	0.00084	0.00087	0.00066	0.0013	0.0012	0.0011	0.0014	0.0015	0.0016	0.00076
Silver							0.00036		0.00035		0.00028		0.00027	
Sodium	22.3	24.2	34.9	18.1	36.3	17.2	9.4	17.1	15.9	16.6	16.4	10.1	24.2	9.9
Thallium			0.000054								0.00003	0.000075	0.000033	
Vanadium	0.016	0.013	0.013	0.014	0.013	0.015	0.013	0.013	0.014	0.013	0.012	0.014	0.013	0.012
Zinc	0.026	0.031	0.032	0.029	0.031	0.056	0.041	0.026	0.037	0.025	0.022	0.02	0.021	0.016
Volatile Organic Compounds - Method 8260A (mg/L)														
Acetone		0.0024		0.0029	0.0012	0.0025	0.0031	0.003	0.003		0.0018	0.0013		0.0023
Methylene chloride	0.0019	0.0022	0.0019	0.0018	0.0017	0.0015								
Wet Chemistry - Methods 130.2/160.1/160.2/ 300.0A/310.1/410.4/415.1 (mg/L)														
Chemical Oxygen Demand (COD)														12.4
Chloride	20	31.3	54	19.3	53	18.3	6.9	17.1	16	16.5	16.3	10.7	10.8	7
Hardness, as CaCO3	220	172	180	172	196	172	156	172	164	188	180	204	204	196
Sulfate	10.8	5.9	6	6.4	6.5	7.6	4.5	7.1	10.6	8.1	8.6	12.2	12.6	6.4
Total Alkalinity	232	194	192	190	204	186	174	182	178	204	184	234	222	216
Total Dissolved Solids	437	384	396	104	221	194	154	173	179	211	179	259	310	262
Total Organic Carbon	1.6	1			0.96	2.1	2.1	2.1	2.7	2	2	1	1.2	4.1
Total Suspended Solids						6.8	8						4.8	